ARIZONA
DEPARTMENT OF
TRANSPORTATION

STANDARD SPECIFICATIONS

FOR

ROAD AND BRIDGE CONSTRUCTION

2027

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The 2027 ADOT Standard Specifications for Road and Bridge Construction and its associated Supplement are available in electronic format. No hard copies are available for purchase.

INTRODUCTORY

Revision marks, vertical lines in the right margin, have been added to these Specifications to highlight areas where changes have occurred since the 2021 edition. Revision marks appearing in the space between two paragraphs are indicative of a deletion of a paragraph from the 2021 Edition.

The revision marks are intended to facilitate location of new material but provide no guarantee, explicit or implicit, that text not highlighted has appeared in prior editions of these Specifications.

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SECTION 100 GENERAL:

Titles and headings are for convenience of reference and have no bearing on the interpretation of these specifications.

When a publication is specified, it refers to the most recent date of issue, including interim publications, before the bid opening date for the Project, unless a specific date or year of issue is provided.

In the contract, the words "or equal", referring to a product, material, or process, mean "equal as determined by the Department."

Unless the context clearly indicates otherwise, the words "as indicated" or "indicated" mean "as indicated or indicated on the contract plans."

SECTION 101 DEFINITIONS AND TERMS:

101.01 Abbreviations:

Wherever the following abbreviations are used in these specifications or in other contract documents, they are to be construed the same as the respective expressions represented:

AAA	Aluminum Alloy Association
AAMA	Architectural Aluminum Manufacturer's Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACA	American Cement Association
ACI	American Concrete Institute
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AEC	Arizona Electric Code
AF&PA	American Forest & Paper Association
AGA	American Gas Association

AGC	Associated General Contractors of America
AHERA	Asbestos Hazard Emergency Response Act
AIA	American Institute of Architects
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALS	American Lumber Standards
ANSI	American National Standards Institute
APA	American Plywood Association
ARA	American Railway Association
AREA	American Railway Engineering Association
ARPA	Arizona Rock Products Association
ARS	Arizona Revised Statutes
ARTBA	American Road and Transportation Builders Association
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASHVE	American Society of Heating and Ventilating Engineers
ASLA	American Society of Landscape Architects
ASLD	Arizona State Land Department
ASME	American Society of Mechanical Engineers
ASRE	American Society of Refrigerating Engineers

ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
ATTI	Arizona Technical Testing Institute
AVE	Arithmetic Mean
AWG	American Wire Gauge
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWS	American Welding Society
AWWA	American Water Works Association
AZI	American Zinc Institute
BLM	Bureau of Land Management
CISPI	Cast Iron Soil Pipe Institute
CFR	Code of Federal Regulations
CPI	Clay Pipe Institute
CRA	California Redwood Association
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
DBE	Disadvantaged Business Enterprise
EIA	Electronic Industries Association
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
FGJA	Flat Glass Jobber's Association
FHWA	Federal Highway Administration
FM	Factory Mutual

FSS	Federal Specifications and Standards, General Services Administration
IAL	Independent Approved Laboratory
IAPMO	International Association of Plumbing and Mechanical Officials
IES	Illuminating Engineering Society
IFI	International Fasteners Institute
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineer's Association
ISO	International Organization for Standardization
ISSA	International Slurry Surfacing Association
ITE	Institute of Transportation Engineers
MAG	Maricopa Association of Governments
MUTCD	Manual on Uniform Traffic Control Devices
NAAMM	National Association of Architectural Metal Manufacturers
NBFU	National Board of Fire Underwriters'
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NCPI	National Clay Pipe Institute
NCPRC	National Clay Pipe Research Corporation
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association

NICET	National Institute for Certification in Engineering Technologies
NIST	National Institute for Standards and Technology (U.S. Department of Commerce)
NLMA	National Lumber Manufacturer's Association
NRMCA	National Ready Mixed Concrete Association
NSF	National Sanitation Foundation
NSPS	National Society of Professional Surveyors
NTPEP	National Transportation Product Evaluation Program
OSHA	Occupational Safety and Health Administration/Act
PCI	Precast/Prestressed Concrete Institute
PLP	Plastic Laminate Producers
PPI	Plastic Pipe Institute
PS	Product Standard, Product Standard Section, U.S. Department of Commerce
PTI	Post-Tensioning Institute
PUESR	Pacific Utilities Electrical Service Requirements
RMA	Radio Manufacturer's Association
SAE	Society of Automotive Engineers
SSPC	Society for Protective Coatings
TCA	Tile Council of America
UBC	Uniform Building Code
UL	Underwriters' Laboratories, Inc.
UPC	Uniform Plumbing Code
USS	United States Standard
WCLA	West Coast Lumberman's Association

WCLIB West Coast Lumber Inspection Bureau

WIA Woodwork Institute of Arizona

WWPA Western Wood Products Association

101.02 Definitions:

Wherever in the contract the following are used, the intent and meaning shall be interpreted as follows:

Addendum:

A revision to the contract made available to the Bidders after Advertisement for bids and before opening of Proposals.

Advertisement for Bids:

The public announcement inviting bids for the work.

Aggregate:

Inert material such as sand, gravel, broken stone, crushed stone, or a combination thereof.

Average Value (AVE):

The arithmetic mean of a set of values, which is defined as the sum of all of the values divided by the number of values.

Award:

The acceptance by the Transportation Board of a proposal to perform the work.

Backfill:

Material placed in an excavated space to fill such space.

Bidder:

An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, submitting a proposal.

Bid Documentation:

Bid documentation shall consist of all writings, working papers, computer printouts, charts, and data compilations that contain or reflect information, data, or calculations used by the Bidder to determine the

estimated costs, resources and/or time to be devoted to the work, and all documents used to prepare the bid or proposal, including material relating to the determination and application of:

Equipment rates
Overhead rates
Time schedules
Labor rates
Efficiency or productivity rates
Arithmetic extensions
Subcontractor and Material Supplier Quotations

Any manuals standard to the industry used by the Bidder in determining the Bid Proposal are also considered Bid Documentation. These manuals may be included in the Bid Documentation by reference and shall show the name and date of the publication and the publisher.

The term “Bid Documentation” does not include documents provided by the Department for the Bidder’s use in the preparation of the Bid Proposal, unless the contractor's notes are attached to these documents.

Bid Item:

A Pay Item.

Bid Schedule:

The prepared schedule containing the estimated quantities of the pay items for which unit bid prices are invited.

Bridge:

A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway and having a track or passageway for carrying traffic or other moving loads and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or extreme ends of openings for multiple boxes.

(A) Bridge Length: The greater dimension of a structure measured along the center of the roadway between the backs of abutment backwalls or between ends of bridge floor.

(B) Bridge Roadway Width: The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

(C) Substructure: All that part of a structure below the bearings of simple and continuous spans, skewbacks of arches and top of footings of rigid frames; including backwalls, wingwalls and wing protection railings.

(D) Superstructure: All that part of a structure above the bearings of simple and continuous spans, skewbacks of arches and top of footings of rigid frames; excluding backwalls, wingwalls, and wing protection railings.

Calendar Day:

Any day shown on the calendar, beginning at midnight, extending for a 24-hour period, and ending at midnight.

Channel:

A natural or artificial watercourse.

Characteristic:

A measurable or an observable property of a material, product, or item of construction.

Compensable Delay:

See Delay.

Complete in Place:

Complete in place means that payment will be full compensation for all work necessary to complete that portion of the contract in its entirety to the satisfaction of the Engineer, in accordance with the requirements of the contract. When the basis of payment states the work will be paid for complete in place it shall be the contractor's responsibility to determine the elements necessary to complete the work.

When the basis of payment includes a list of elements associated with the complete in place work, the list shall not be construed to limit the work to the listed elements.

Conduit:

A pipe used for receiving and protecting wires or cable.

Construction Easement:

A right to use or control property outside of the established right-of-way limits for a designated project.

Contract:

The written agreement between the Department and the contractor setting forth the obligation of the parties, including the performance of the work, the furnishing of labor and materials and the basis of payment.

The contract includes the advertisement for bids, proposal, bidding schedule, contract agreement, and contract bonds, certificates of insurance, Standard Specifications, Special Provisions, project plans, Standard Drawings, documents incorporated by reference, and any supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized time extensions, all of which constitute one instrument.

Contract Bonds:

Surety Bonds that include Performance Bond and Payment Bond.

Contract Item:

A Pay Item.

Contract Time:

The number of working days or calendar days allowed for completion of the contract, including authorized time extensions.

If a completion date is specified in the contract, the contract time expires on that date.

Contractor:

The individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, contracting with the Department for performance of the work.

Controlling Item:

A work activity in which any delay in its completion will result in a delay in the completion of the contract.

Culvert:

Any structure, not classified as a bridge, which provides an opening under the roadway.

Day:

A calendar day.

Deficiency:

Departure from, or noncompliance with, specified criteria.

Delay:

Any event, action, force, or factor that causes the length of time needed to perform the work to increase.

(A) Compensable Delay. An excusable delay for which the contractor may be entitled to additional compensation in addition to any extension of time granted.

(B) Excusable Delay. A delay to the contract or a milestone completion date which was unforeseeable and beyond the contractor's control, for which a time extension may be granted.

(C) Noncompensable Delay. An excusable delay for which the contractor may be entitled to an extension of time without additional compensation.

(D) Nonexcusable Delay. A delay to the contract or milestone completion date that was reasonably foreseeable or within the control of the contractor for which no compensation or time extension will be granted.

Department:

The Arizona Department of Transportation as constituted under the laws of the State of Arizona.

Design Purpose:

The set of design criteria for the finished project, or any part thereof, including strength, service life, economy of construction, ease of maintenance, appearance, and safety.

Director:

The Arizona Department of Transportation Director, acting by and under the authority of the laws of the State of Arizona.

Engineer:

The State Engineer, acting by and under the authority of the laws of the State of Arizona, or the State Engineer's representative in matters relating to contract development, administration and construction activities. The use of the word Engineer in these specifications relates

to the State Engineer, District Engineer, Resident Engineer, Project Supervisor, or Inspectors within the limits of their authority.

Equipment:

All machinery, equipment, tools and apparatus, together with the necessary supplies for upkeep and maintenance, necessary for the proper construction and acceptable completion of the work.

Equitable Adjustment (Adjustment, Contract Adjustment):

An increase or decrease in the contract price or time made by Supplemental Agreement in accordance with Subsections 108.08 and 109.04 of the specifications.

Excusable Delay:

See Delay.

Extra Work:

Work to be performed by the contractor not provided for in the contract, but found essential for the satisfactory completion of the project.

Highway, Street, or Road:

A general term denoting a public way for purposes of travel, vehicular, pedestrian or by other means, including the entire area within the right-of-way.

Holidays:

Those days defined as legal holidays in A.R.S., Section 1-301, on the date of the bid opening.

Independent Approved Laboratory:

A testing laboratory which has been approved by the Engineer to perform testing and which has been determined by the Engineer to be free from any conflict of interest.

Inspector:

The Engineer's authorized representative assigned to make detailed inspections of contract performance.

Laboratory:

The testing laboratory of the Department or any other testing laboratory which is certified or approved by the Department.

Liquidated Damages:

A specified amount set forth in the contract as a reasonable estimate of the Department's damages caused by the contractor's failure to substantially complete the contract within the contract time.

Lot:

A designated or measured amount of construction or quantity of material assumed to be produced by the same process.

Lump Sum:

The price bid by a contractor as a single amount for a complete contract item as defined by the specifications, or a price proposed by a contractor as a single amount for the performance of extra work.

Major Items:

A major item is an item whose total cost, determined by multiplying the bidding schedule quantity and the contract unit price, is equal to or greater than the amount indicated below.

A major item will remain a major item unless it is completely eliminated.

When the original total contract dollar amount is:		**A major item shall be equal to or greater than the following amount:** (in dollars)
Equal to or greater than:	But less than:	
0.00	100,000	5,000
100,000	200,000	10,000
200,000	450,000	15,000
450,000	750,000	25,000
750,000	1,100,000	35,000
1,100,000	1,500,000	45,000
1,500,000	2,000,000	55,000

When the original total contract dollar amount is: Equal to or greater than:	But less than:	**A major item shall be equal to or greater than the following amount:** (in dollars)
2,000,000	2,500,000	65,000
2,500,000	3,000,000	75,000
3,000,000	5,000,000	85,000
5,000,000	7,000,000	120,000
7,000,000	10,000,000	150,000
10,000,000	25,000,000	250,000
25,000,000	50,000,000	350,000
50,000,000	---	500,000

Materials:

Substances used in the construction of the project.

Median:

The untraveled portion of the highway, street or road which separates the traveled roadway from traffic flowing in opposite directions.

Minor Item:

Any item which is not a major item.

Noncompensable Delay:

See Delay.

Non-Excusable Delay:

See Delay.

Notice of Award:

Written notice to the contractor stating that its proposal has been accepted by the Transportation Board.

Pavement Structure:

The combination of subbase, base course, and/or surface course placed to support the traffic load.

(A) Subbase Course: One or more layers of specified or selected materials, of designed thickness, placed on the subgrade to support a base course.

(B) Base Course: One or more layers of specified materials, of designed thickness, placed on a subbase course or a subgrade to support a surface course.

(C) Surface Course: One or more layers of specified materials designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion and the disintegrating effects of climate. The top layer is sometimes called a "wearing course."

Pay Item (Item):

A detail of work for which payment is made under the contract.

Plans:

The project plans, Standard Drawings, working drawings and supplemental drawings, or reproductions thereof, approved by the Engineer, which show the location, character, dimensions and details of the work to be performed. All such documents are to be considered as a part of the plans whether or not they are reproduced in the proposal pamphlet.

(A) Standard Drawings:

Drawings approved by the Department for repetitive use, showing details to be used where appropriate.

All Standard Drawings approved by the Department plus subsequent revisions and additions are listed on the project plans along with the latest (current) revision dates.

Standard Drawings are available at www.azdot.gov.

(B) Project Plans:

Specific details and dimensions peculiar to the work which are supplemented by the Standard Drawings insofar, as applicable.

(C) Working Drawings and Supplemental Drawings:

Supplemental design sheets, shop drawings, or similar data which the contractor is required to submit to the Engineer such as stress sheets, erection plans, falsework plans, forming plans for cast-in-place bridge girders, framework plans, cofferdam plans, bending diagrams for reinforcing steel, computations, or any other supplementary data required of the contractor.

Professional Engineer:

A person who has been granted registration in one or more branches of engineering by the Arizona State Board of Technical Registration, and is authorized to practice professionally in the State of Arizona. If a branch of engineering is included in the title, such as Professional Civil Engineer, registration in that branch shall be required.

Profile Grade:

The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal center line of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

Project:

The specific section of the highway on which construction is to be performed as described in the contract.

Proposal (Bid, Bid Proposal):

The offer of a bidder, on the prescribed forms, to perform the work at the prices quoted and within the time specified.

Proposal Guaranty (Surety Bid Bond):

The security furnished with a bid to guarantee that the bidder will enter into the contract if its proposal is accepted.

Quality Control:

Contractor or supplier techniques and activities that are performed or conducted to fulfill the contract requirements.

Random Sampling:

Sampling performed so that each increment in the lot has an equal chance of being chosen, with sampling frequency determined by the use of random numbers.

Range:

Specified limits of acceptability for a measured characteristic.

Reasonably Close Conformity:

Where working tolerances are specified, reasonably close conformity means compliance with such working tolerances. Where working tolerances are not specified, reasonably close conformity means compliance with reasonable and customary manufacturing and construction tolerances.

Registered Engineer:

A Professional Engineer.

Registered Land Surveyor:

A person who has been granted registration in Land Surveying by the Arizona State Board of Technical Registration for Architects, Assayers, Engineers, Geologists, Landscape Architects and Land Surveyors, and who is authorized to practice professionally in the State of Arizona.

Responsive Bid:

A bid which meets all requirements of the proposal pamphlet.

Responsible Bidder:

A bidder that is a responsible contractor.

Responsible Contractor:

A contractor that has the requisite skill, resources, desire, and integrity to complete the work in conformance with the provisions of the contract.

Right-of-Way:

A general term denoting land, or an interest therein, as acquired for or devoted to transportation purposes.

Roadbed:

The graded portion of a highway, prepared as a foundation for the pavement structure and shoulders.

Roadside:

A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

Roadside Development:

Activities which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching and the placing of other ground covers; or such planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

Roadway:

That portion of the right-of-way required for construction, limited by the outside edges of slopes, including ditches, channels and all structures pertaining to the work.

Section (When referring to the Specifications):

A numbered article or group of related articles forming a part of the specifications and applying to or controlling the procedure of an operation or regulation.

Shoulder:

The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use and for lateral support of base and surface courses.

Sidewalk:

That portion of the roadway primarily constructed for the use of pedestrians.

Specifications:

The compilation of provisions and requirements for the performance of prescribed work including:

(A) Standard Specifications: This book of specifications, which is approved for general application and repetitive use.

(B) Special Provisions: Additions and revisions to the Standard Specifications covering conditions and requirements peculiar to an individual project.

Standard Deviation (s):

A measure of variability that can be calculated from the differences between individual measurements in a group and their average. Unless otherwise specified, standard deviation is calculated as follows:

$$s = \sqrt{\frac{\Sigma (x_i - AVE)^2}{n - 1}}$$

Where: s = standard deviation
xi = individual value
AVE = average value
N = number of values

State:

The State of Arizona, acting through its authorized representatives.

Structures:

Bridges, culverts, catch basins, drop inlets, retaining walls, manholes, endwalls, buildings, sewers, service pipes, under drains, foundation drains and other features which may be encountered in the work and not otherwise classified.

Subcontractor:

An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, to which the contractor sublets a part of the contract with the approval of the Department.

Subgrade:

The roadbed materials beneath the pavement structure. The top prepared surface of the subgrade is called finished subgrade elevation.

Superintendent:

The contractor's authorized representative in responsible charge of the work.

Supplemental Agreement:

A written agreement between the Department and the contractor covering work not otherwise provided for in the contract, for extensions or reductions of contract time or revisions in or amendments to the terms of the contract. A supplemental agreement becomes a part of the contract when signed by the contractor and the Department.

Supplier:

One who fabricates, or processes an item off the project site, and who may or may not deliver this item to the project. For purposes of this definition, a supplier shall not include one who establishes a fabricating process or facility expressly for use of the project, whether on or off the project site; or one who performs work on the project site that is incorporated into the project.

Surety:

The corporate body or bodies bound with and for the contractor, for the full and complete performance of the contract and for payment of all debts pertaining to the work.

Transportation Board:

The Transportation Board acting under authority of the laws of the State of Arizona.

Traveled Way:

The portion of the roadway for the movement of vehicles, exclusive of shoulders.

Unbalanced Bid, Materially:

A bid that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the Department.

Unbalanced Bid, Mathematically:

A bid containing lump sum or unit bid prices that do not reflect reasonably anticipated actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

Unit Price:

The price bid by the contractor for one unit of work, as defined by the specifications.

Work:

Work shall mean the furnishing of all labor, materials, equipment and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

Working Day:

A day, exclusive of Saturdays, Sundays and State-recognized holidays, beginning at midnight, extending for a 24-hour period, and ending at midnight. Any Saturday, Sunday, or State-recognized holiday on which the contractor has been approved to work will also be counted as a working day. Working days on which weather conditions do not permit work on the project to proceed, as determined by the Engineer, will not be charged.

SECTION 102 BIDDING REQUIREMENTS AND CONDITIONS:

102.01 Contract Documents:

(A) General:

The Contract Documents, including but not limited to, Advertisement for Bids, Project Plans, and Proposal Pamphlets will be available in electronic format, on the ADOT Contracts and Specifications Group website. Any interested party may access the advertised Contract Documents.

(B) Advertisements for Bids:

The advertisement for bids may contain the following information:

- Programmed Amount,
- Project number and name of highway,
- Route number and mileposts,
- Date and time of opening of bids,
- Location of the project,
- General description of work,
- Specified contract time for completion of contract work,
- Statement of proposal requirements,
- Manner in which project plans and specifications may be obtained,
- Type and amount of proposal guaranty.

(C) Proposal Pamphlet:

The Proposal Pamphlet will include the location and general description of the contemplated construction, an approximate estimate of the quantities and types of work to be performed and/or materials to be furnished, a schedule of bid items for which unit prices are invited, the specified time for completion, any applicable Special Provisions or supplemental requirements, and all necessary bidding documents.

102.02 Prerequisites for Bidding:

(A) General:

To submit a valid bid, the bidder shall:

(1) Have prequalification from the Department as necessary for the project, in accordance with Subsection 102.02(B) of the specifications; and

(2) Be included on the project Plansholder List as a Prime in accordance with Subsection 102.02(C) of the specifications.

(B) Prequalification of Bidders:

Prior to submitting a bid, the bidder will (unless waived by the Department) be required to be prequalified with the Department to bid on the project. The submission of Prequalification information and determination of Prequalification shall be in accordance with the requirements of the Rules for Prequalification of Contractors as approved and adopted by the Department.

(C) Plansholder List:

It is the bidder's responsibility to ensure that their firm is on the Plansholder List as a Prime prior to submitting a bid.

Firms can register electronically requesting placement on the project Plansholder List as a Prime contractor as follows:

(1) Go to the ADOT Contracts and Specifications Group Website;

(2) Select "Current Advertisements";

(3) Identify the project of interest;

(4) Click on the "Register" icon;

(5) Select the "Bidder" radio button;

(6) Complete all required fields;

(7) Click "Save". This submits the request to the Department; and

(8) If all required information is provided, the "ADOT C&S Advertisement Registration Confirmation" Screen will appear. An email will also be sent to the email address provided acknowledging the receipt of the request.

Requests to be included on the Plansholder List as a Prime will be evaluated by the Department to determine whether the bidder is prequalified for the project. The Department cannot guarantee that requests to be on the Plansholder List will be considered if the request is submitted less than five working days prior to the bid opening. The Department will send an email to the email address provided notifying the contractor of the results of their request.

The Department's email will state whether the request was approved or denied. More information regarding the Department's decision may be obtained by contacting the ADOT Contracts and Specifications Group.

If an individual from a firm submits a duplicate request to be placed on the Plansholder List, the request will be denied. The Department will register the contact person listed on the duplicate request to receive email notices of updates to the project. The Department will send an email to the email address provided notifying the contractor of the results of their request.

(D) Registration for Notifications:

Subcontractors, Vendor and other interested parties may electronically register to receive email notifications regarding updates or changes to specific advertised contracts.

To register:

(1) Go to the ADOT Contracts and Specifications Group Website;

(2) Select "Current Advertisements";

(3) Identify the project of interest;

(4) Click on the "Register" icon;

(5) Select the "Other" radio button, as applicable;

(6) Select the "Yes" in response to the prompt "Are you interested in registering to be notified about any changes made to this advertisement?";

(7) Complete all required fields;

(8) Click "Save". This submits the request to the Department; and

(9) If all required information is provided, the "ADOT C&S Advertisement Registration Confirmation" Screen will

appear and a confirmation email will be sent to the email address provided.

All registered parties will receive notifications when changes are made to the associated contract advertisement.

102.03 Suspension from Bidding:

The Department may suspend any person and any subsidiary or affiliate of any person from further bidding to the Department and from being a subcontractor or a supplier or otherwise participating in the work:

(A) If that person or any officer, director, employee or agent of that person is convicted, in this State, or any other jurisdiction, of a crime involving any of the following elements or actions:

(1) Entering into any contract, combination, conspiracy or other unlawful act in restraint of trade or commerce;

(2) Knowingly and willfully falsifying, concealing, or covering up a material fact by trick, scheme, or device;

(3) Making false, fictitious, or fraudulent statements or representations;

(4) Making or using a false writing or document knowing it to contain a false, fictitious, or fraudulent statement or entry;

(5) Misrepresentation or false statement on any application for bonding;

(6) Misrepresentation or false statement on any application for prequalification;

(B) If the Department makes a finding of any of the above or finds that the contractor is not a Responsible Bidder or a Responsible Contractor; or

(C) If the Department determines that a contractor, subcontractor, or supplier has repeatedly or willfully failed to comply with federal or state immigration laws.

Under this subsection, a person means any individual, partnership, joint venture, corporation, association, or other entity formed for the purpose of doing business as a contractor, subcontractor, or supplier.

102.04 Availability of Documents:

The following documents, if applicable, will be available in electronic format on the ADOT Contracts and Specifications Group website:

A. Project Plans.
B. Advertisement for Bids.
C. Proposal Pamphlet.
D. Cross Sections.
E. Earthwork Report.
F. Other Available Reports.
G. Existing Ground Digital Terrain Model (DTM).
H. Design Ground Digital Terrain Model (DTM).
I. Survey Control Sheet.

The project plans, proposal pamphlet, cross sections, earthwork report, survey control sheet, and any applicable reports are provided in PDF format. The Department makes no representation or warranties as to the compatibility, usability, or readability of the PDF documents with any system, software, hardware, or application package other than that on which the files were originally saved. The contractor bears the sole risk of any modifications, manipulations, or alterations to the plans, proposal pamphlet, and any applicable reports.

The existing ground DTM and the design DTM, if applicable, are provided in either DTM or DGN files for informational purposes only. The DTMs are not part of the contract documents. The contractor's use of the information in the DTMs is at the contractor's sole risk. The Department makes no representation or warranties as to the compatibility, usability, or readability of the DTMs with any system, software, hardware, or application package other than that on which the files were originally prepared. The version of Microstation used to save the DTMs is indicated at https://azdot.gov/business/engineering-and-construction/computer-aided-design-and-drafting-cadd.

The Department is providing the available electronic project documents to bidders for informational purposes in conjunction with work or services to be provided to the Department under the contract. Any use of the electronic files for any purposes other than for this project is prohibited.

102.05 Plansholder Eligibility:

The Department reserves the right to disqualify a prequalified contractor from being a Plansholder for any of the following reasons:

(A) Lack of competency or adequate machinery, plant and other equipment, as revealed by the financial statement and experience questionnaires required under Subsection 102.02 of the specifications.

(B) Incomplete work which, in the judgment of the Department, might hinder or prevent the prompt completion of additional work if awarded.

(C) Failure to pay, or settle satisfactorily, all bills due for work on other contracts.

(D) Failure to comply with any qualification regulations of the Department.

(E) Default under previous contracts.

(F) Unsatisfactory performance on previous work.

(G) Entering into any contract, combination, conspiracy, or other unlawful act in restraint of trade or commerce.

(H) Knowingly and willfully falsifying, concealing, or covering up a material fact by trick, scheme, or device.

(I) Making false, fictitious, or fraudulent statements or representations.

(J) Making or using a false writing or document knowing it to contain a false, fictitious, or fraudulent statement or entry.

(K) Misrepresentation or false statement on any application for bonding.

(L) Misrepresentation or false statement on any application for prequalification.

(M) Lack of sufficient ability or integrity to complete the contract.

102.06 Interpretation of Quantities in Bidding Schedule:

The quantities appearing in the bidding schedule, except as provided elsewhere, are approximate only and are prepared for the comparison of bids. Payment to the contractor will be made only for the actual quantities of work performed and accepted or materials furnished in accordance with the requirements of the contract. The scheduled quantities of work to be done and materials to be furnished may each be increased, decreased, or omitted as hereinafter provided in Subsection 104.02 of the specifications.

102.07 Examination of Plans, Specifications and Site of Work:

The bidder shall examine the site of the proposed work and the contract before submitting a Proposal. If no site investigation is performed, the bidder is responsible for all site conditions that should have been discovered had a reasonable site investigation been performed. The submission of a Proposal will be considered conclusive evidence that

the bidder is satisfied with the conditions to be encountered in performing the work and as to the requirements of the proposed contract.

The bidder shall take no advantage of any apparent error or omission in the plans, bid schedule items, estimated quantities, specifications, or other contract documents. In the event the bidder discovers such an error or omission, the bidder shall immediately notify the Department. The Department will then make such corrections and interpretations as may be deemed necessary.

Any request for explanation of the meaning or interpretations of the contract shall be submitted in adequate time to allow a reply to reach all bidders before submission of their Bid Proposal. If the Department determines interpretations or explanations are warranted, the response will be issued, if necessary, through an addendum to the contract documents, and will be made available to all prospective bidders before the time set for opening of Proposals.

The Department will not be bound by any statement or representation concerning conditions or description of the work unless they are included in the contract. Oral explanations, interpretations, or instructions given before the opening of the bids by Department employees or agents are not binding.

102.08 Preparation of Proposal:

(A) General:

The bidder shall prepare and submit its proposal using Department-approved bid preparation software.

Proposals shall be prepared and submitted in accordance with the requirements of Subsection 102.08(B) of the specifications.

The bidder shall submit its proposal using the electronic bid process described herein.

(B) Electronic Submittal:

(1) General:

In order to submit a bid electronically, a firm shall have obtained a bidder identification number from the Department, at the office of ADOT Contracts and Specifications Group, 205 South 17th Avenue, MD 121F, Phoenix, AZ 85007, phone (602) 712-7221.

In addition, bidders shall subscribe to Info Tech, Inc., doing business as Infotech's Bid Express® service at www.bidx.com, an online bidding service, and obtain an online Digital ID. Bid Express can be reached at www.bidx.com, phone (888)-352-2439 and/or

customer.support@bidx.com. The bidder shall also download and install a copy of the AASHTOWare Project Bids Bid Component from the internet at the Bid Express website. The version of the software currently used by ADOT can then be located by selecting the ADOT tab and the "AASHTOWare Project Bids" link under Downloads.

In order to obtain a Digital ID, bidders shall name at least one authorized signatory, as approved by the Department to commit the firm to the terms and conditions specified in the Proposal and the contract documents.

The bidder shall download the electronic copy of the project EBSX file, listed as an AASHTOWare Project Bids Data File on the Bid Express website. The file includes a schedule of items folder containing the bid schedule, a miscellaneous data folder containing the proposal and attachments, contractor authorization folder containing bidders's contact information, and a bid bond folder. The bidder shall review the proposal and complete the bidding schedule, as specified herein, and the attachments.

The bidder shall include with its bid an email address and recipient name as its contact information for the purpose of receiving the notice of award or other notices related to the bidding. The Department will send the notice of award, executed contract and other notices to the requested email address and recipient name.

It is the contractor's responsibility to provide the updated contact information to the Department if there are any changes to the above requested email address or recipient name prior to the award of the contract.

The bidder shall specify a unit price for each pay item for which a quantity is given in the bidding schedule. The software will automatically produce the extended amount, as the product of the quantity given and the specified unit price.

The bidder shall also download all addenda files issued and update the project file accordingly. The bidder shall be responsible for the successful submission of its electronic bid prior to the time specified for submission of bids. The bidder agrees that the Department bears no liability resulting from the bidder's failure to successfully submit an electronic bid.

(2) Procedure for Missing Bids:

If a bidder believes that its electronically submitted bid should have been read at the bid opening but was not read, the bidder shall notify the Department at CSGroup@azdot.gov of the apparent irregularity and provide its bid receipt for the bid in question no later than three hours after the time specified for submission of bids.

Upon proper notification of a missing bid by a bidder, the Department will notify all bidders that a missing bid has been reported. The Department will begin an investigation to determine the status of the bid, and will review all electronic bids received from Bid Express service.

The Department will direct Infotech to review their records and determine whether the missing bid was submitted. Infotech will make a determination about receipt of the bidder's missing bid.

If requested by the Department, Infotech will attempt to retrieve a copy of the encrypted bid from the bidder's computer.

The Department will partner with Infotech and implement best practices to configure the Bid Express service to decrypt the bid.

If the Department determines that a bid cannot be recovered, the Department will notify all bidders of its determination.

If a missing bid is recovered, the Department will determine the validity of the bid, and may recommend award of the contract to the bidder submitting the missing bid if appropriate. The Department will notify all bidders.

102.09 Non-Collusion Certification:

By submission of its bid electronically, the bidder makes the certification stated in the following paragraph, binding as if it had been signed by the bidder.

> The bidder certifies that, pursuant to Subsection 112(c) of Title 23, United States Code and Title 44, Chapter 10, Article 1 of the A.R.S, neither it nor anyone associated with the company, firm, corporation, or individual has, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the submitted bid.

102.10 Irregular Proposals:

(A) Proposals may be considered irregular and may be rejected for any of the following reasons:

(1) If there is a submission of any kind which may tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.

(2) If the bid is mathematically unbalanced.

(3) If the bid is materially unbalanced.

(B) Proposals will be considered irregular and will be rejected for any of the following reasons:

(1) If the bidder or surety fails to provide a proposal guaranty as specified in Subsection 102.11 of the specifications.

(2) If the bidding schedule does not contain a unit price for each pay item listed.

(3) If the bidder fails to meet the required goal for Disadvantaged Business Enterprises (DBE) established in the Special Provisions or show good faith effort as determined by the Department.

102.11 Proposal Guaranty:

The bidder shall provide an electronic proposal guaranty payable to the Arizona Department of Transportation for 10 percent of the amount of the bid.

The surety (bid) bond shall be executed by the bidder and a surety company or companies holding a certificate of authority to transact surety business in this State issued by the Director of the Department of Insurance. The agent for the surety shall be licensed to act as an insurance agent in Arizona.

Bidders shall provide an electronic proposal guaranty as described herein.

Two companies have established web-based surety processing procedures with Bid Express: Surety 2000 (https://surety2000.com/) and Tinubu (https://www.tinubu.com/). Bidders may contact these companies for additional information and requirements on electronic proposal guaranty.

102.12 Withdrawal of Proposals:

(A) General:

A bidder may withdraw its electronic submittal at a minimum 30 minutes prior to the time specified for bid opening in writing to the Contracts and Specifications Manager through the Contract and Specifications Group email at CSGroup@azdot.gov.

(B) Conditional Withdrawal:

When proposals for more than one contract are to be publicly read on any one date, a bidder may request, in the event it is the apparent low

bidder on a given contract or contracts, that one or more subsequent bids be withdrawn.

The bidder shall submit a written request for conditional withdrawal to the Contracts and Specifications Group Manager via email at CSGroup@azdot.gov a minimum of 30 minutes prior to the specified bid opening time.

102.13 Combination or Conditional Proposals:

At the Department's discretion, proposals may be issued for projects either separately or in combination. Bidders may submit bids for the combination or for individual units within the combination, as allowed in the proposal. The Department reserves the right to award contracts based on separate or combination bids, whichever is most advantageous to the state. Only combination bids specifically authorized in the Department's proposal will be considered.

102.14 Public Opening of Proposals:

Proposals will be opened and read aloud at the time indicated in the advertisement for bid.

Bidders, their authorized agents and other interested parties may attend the bid opening while they are read aloud. After the completion of the bid opening, the as-read bid results will then be made available through the ADOT Contracts and Specifications Group website.

102.15 Licensing:

It is the responsibility of the bidder to determine whether it has the appropriate contracting licenses to perform the work. For all projects except Federal-aid funded projects, the bidder shall have the proper licenses at the time of bid opening. The successful bidder's failure to meet with the necessary license requirements at the time of bid opening will result in the rejection of the bid.

On Federal-aid funded projects, the bidder is not required to have the licenses at the time of bidding, but it must procure the licenses from the State Registrar of Contractors, in accordance with A.R.S. 32 1101 et seq. before award can be made, and no later than 60 days after the date bids are opened. The bidder's failure to get the necessary licenses within 60 days after the bid opening date will result in rejection of the bid.

Licensing information is available from:

Arizona Registrar of Contractors
1700 W. Washington St. Suite 105
Phoenix, AZ 85007-2812
Phone: (602) 542-1525

Email: licensing@roc.az.gov
www.roc.az.gov

102.16 Boycott of Israel:

All bidders are required to certify in their bid proposal on the "Participation in Boycott of Israel Certification" form either:

(A) The bidder does not participate in, and agrees not to participate in during the term of the contract, a boycott of Israel in accordance with ARS 35-393.01; or

(B) The bidder does participate in a boycott of Israel as defined in ARS 35-393.01.

The Department will not recommend award of the contract unless the bidder makes the certification described in subparagraph (A) of this Subsection.

102.17 Forced Labor of Ethnic Uyghurs Ban:

All bidders are required to certify in their bid proposal on the "Forced Labor of Ethnic Uyghurs Ban Certification Form" either:

(A) The bidder does not use the Forced labor of Ethnic Uyghurs as described in A.R.S. 35-394; or

(B) The bidder does use the Forced labor of Ethnic Uyghurs as described in A.R.S. 35-394.

The Department will not recommend award of the contract if the bidder makes the certification described in subparagraph (B) of this Subsection, unless the bidder uses an exempt contractor.

For the purposes of this subsection, a contractor is defined as an exempt contractor if it is a sole proprietorship; has fewer than 10 employees; and/or is a non-profit organization.

SECTION 103 AWARD AND EXECUTION OF CONTRACT:

103.01 Consideration of Proposals:

After the proposals are opened and read aloud, they will be compared on the basis of the summation of the products of the quantities shown in the bidding schedule by the unit bid prices shown. The results of such comparisons will be available to the public.

The right is reserved to reject any or all proposals, to waive technicalities or to advertise for new proposals if, in the judgment of the

Department, the best interests of the Department will be promoted thereby.

103.02 Interpretation of Proposals:

The Department will consider the following in interpreting proposals:

(A) In the event of a discrepancy between unit bid prices and extension, the unit bid price shall govern.

(B) Unit prices may show up to two decimal places. Decimal places beyond two will be truncated. For example, if the stated unit bid price is $1.128 per unit, the Department will interpret the unit bid price as $1.12 per unit. The extended amount for the affected item(s) and the total bid will be computed accordingly.

(C) The Department will not correct errors in unit bid prices, even if it is demonstrated that the error was a clerical error.

103.03 Responsibility:

The Department will decline to award the contract to any bidder who the Department finds is not a responsible bidder for the particular contract.

A person who has been convicted of a violation of A.R.S. Section 34-252 is not eligible to enter into any contract with the Department for a period of up to three years from date of conviction, as determined by the court. A person means any individual, partnership, corporation, association, or other entity formed for the purpose of doing business as a contractor.

Non-responsibility may also be found for any of the following reasons:

(A) Anti-competitive acts;

(B) Lack of competency and adequate machinery, plant and other equipment, as revealed by the financial statement and experience questionnaires required under Subsection 102.02 of the specifications;

(C) Incomplete work which, in the judgment of the Department, might hinder or prevent the prompt completion of additional work if awarded;

(D) Failure to pay or settle satisfactorily all bills due for work on other contracts;

(E) Failure to comply with any qualification regulations of the Department;

(F) Default under previous contracts;

(G) Unsatisfactory performance on previous work;

(H) Knowingly and willfully falsifying, concealing, or covering up a material fact by trick, scheme, or device;

(I) Making false, fictitious, or fraudulent statements or representations;

(J) Making or using a false writing or document knowing it to contain a false, fictitious, or fraudulent statement or entry;

(K) Lack of a proper contractor's license; or

(L) Lack of sufficient ability or integrity to complete the contract.

103.04 Award of Contract:

The Transportation Board will consider proposals for award within 45 calendar days after the opening of proposals. The Transportation Board reserves the right to postpone action relative to the award of contract until a future Board Meeting. In any case, the Transportation Board will act on proposals no later than 60 calendar days after the opening of proposals. No adjustment in proposed prices will be allowed as a result of any delay caused by the Transportation Board or the Award process.

The award of contract, if awarded, will be made by the Transportation Board to the lowest responsible bidder whose proposal complies with all the requirements prescribed. If there are two or more low responsive bids that are identical in price, award will be made by drawing lots. The successful bidder will be notified by certified letter mailed to the address shown in the bidder's proposal that its bid has been accepted and that it has been awarded the contract.

At any time after completion of the 60-day period set forth above for award of contract, the successful bidder may, by letter, notify the State Engineer of the Department's failure to issue a notice of award letter. If the notice of award letter has not been issued within five days from the date that the successful bidder's letter is received by the State Engineer, the successful bidder shall have the right to withdraw its bid without forfeiture of the bidder's proposal guaranty.

103.05 Cancellation of Award:

The Transportation Board reserves the right to cancel the award of any contract at any time, before the execution of said contract by all parties, without any liability against the Transportation Board or the Department.

103.06 Blank:

103.07 Requirement of Contract Bonds:

The successful bidder shall furnish the Department the following surety bonds, which shall become binding upon the execution of the contract:

(A) A performance bond in the amount of 100 percent of the total contract amount, conditioned upon the faithful performance of the contract in accordance with the plans, specifications, and conditions thereof. Such bond shall be solely for the protection of the Department; and

(B) A payment bond in the amount of 100 percent of the total contract amount solely for the protection of claimants supplying labor or materials to the contractor or its subcontractors in the prosecution of the work, and the payment of all workman's compensation, occupational disease, and unemployment compensation premiums.

The bonds shall be written or countersigned by an authorized representative of the surety. The authorized representative must be either a resident of the State of Arizona or must maintain its principal office in this State. The authorized representative for the surety must be licensed to act as an insurance agent in Arizona. Surety bonds shall be signed by the bidder and by the surety. The surety shall provide a current Power of Attorney attached to the surety bond.

The forms of the bonds will be provided by the Department and will conform to A.R.S., Sections 34-221 through 34-223. Each bond shall be executed solely by a surety company or companies holding a certificate of authority to transact surety business in this State issued by the Director of the Department of Insurance.

103.08 Execution of Contract:

The Department will send the notice of award letter to the successful bidder within two working days after the award, to the email address and recipient given by the bidder as specified in Subsection 102.08(B)(1) of the specifications. This notice will also include the contract and the forms for the payment bond and the performance bond.

The contract shall be executed by the successful bidder in conformance with the electronic procedures given by the Department. The successful bidder shall return the signed contract and bonds in electronic format so as to be received by the Department no later than 10 calendar days after the date of the notice of award letter to the ADOT Contracts and Specification Group mailbox; CSGroup@azdot.gov.

The Department will execute the contract within 20 calendar days after the date of the notice of award letter. No contract shall be considered

as effective until it has been fully executed by both parties. When the Department executes the contract it will send a copy of the executed contract to the contractor's email address and recipient name given by the bidder as specified in Subsection 102.08(B)(1) of the specifications.

103.09 Failure to Execute Contract:

Failure to execute the contract and file satisfactory contract bonds as provided herein within 10 calendar days after the date of the notice of award letter will result in the cancellation of the award and forfeiture of the proposal guaranty to the Department, not as a penalty, but in liquidation of damages sustained. Award may then be made to the next lowest responsible bidder, or the work may be re-advertised as the Department may decide.

The successful bidder acknowledges that if it fails to execute the contract, the Department will suffer damages, including but not limited to the costs of rebidding, costs related to obtaining a contractor, damages due to delayed completion of the project, and damages related to any change in the project conditions caused by delays.

103.10 Bid Disputes:

Any interested party may protest the prospective award of the contract to the apparent lowest responsible bidder, or the refusal of the Department to award the contract to a firm which claims it is the lowest responsible bidder. A protest must be in writing and personally delivered or sent by certified mail, return receipt requested, to the State Engineer. The protest must be received by the State Engineer no later than seven calendar days after the opening of bids, except in the case of a protest concerning compliance with disadvantaged business enterprise provisions. Any protests concerning compliance with disadvantaged business enterprise provisions must be received by the State Engineer no later than seven calendar days after the date required for submittal of the disadvantaged business enterprise affidavit by the apparent low bidder.

The protest shall include facts supporting the protest, any pertinent contractual provisions, law, rules or regulations, and other legal authorities supporting the protest and a requested action. Copies of the protest shall be sent by the protestant to every bidder, at the same time the protest is submitted to the State Engineer.

Any interested party or the Department may submit a response to the protest. The response will include a statement of the requested action, a rebuttal of any of the factual matters in the protest, facts supporting the response, and any contractual provisions, laws, rules, or regulations, or other authority supporting the response.

The response must be received by the State Engineer no later than seven calendar days after the protest is filed.

Statutes, contractual provisions, rules or regulations of the federal government or the state government need not be quoted in full in a protest or response, so long as sufficient citation is given so that the matter cited may be conveniently referenced.

The State Engineer will make a recommendation in writing to the Transportation Board, with copies to the protestant and all parties upon whom service of the protest or response has been made, within seven calendar days after receipt of the response.

The Transportation Board may hear arguments concerning the protest, or at its discretion may direct the State Engineer to hold a hearing or other appropriate procedure to evaluate the protest. If the matter is referred to the State Engineer, the State Engineer's recommendation will be made to the Board within 30 days.

The Transportation Board will make the final decision as to award or the rejection of bids.

Notwithstanding the provisions of Subsection 103.04 of the specifications, in case of any bid protest, the award, if any, must be made by the Transportation Board no later than 75 calendar days after the opening of proposals unless otherwise agreed by the parties.

The times specified in this subsection may be changed by the Engineer with the written agreement of both the apparent low bidder and second low bidder. The times prescribed in this subsection may also be varied in the Special Provisions.

103.11 Escrow of Bid Documentation:

When required by the Special Provisions, each bidder shall submit its Bid Documentation in a separate envelope from the Bid. The Bid Documents will remain unopened during the bid opening period. The documentation of the successful bidder will be placed in escrow with a banking institution or other bonded document storage facility and preserved by that institution or facility as specified in the following subsections. The Bid Documentation for all unsuccessful bidders will be returned.

(A) Submittal of Bid Documentation:

The bidder shall submit the Bid Documentation in a sealed container. The container shall be clearly marked "Bid Documentation" and show on the face of the container the bidder's name and address, the date of submittal, the project number, and the contract number.

(B) Affidavit:

In addition to the Bid Documentation, the bidder shall submit an affidavit, signed under oath by a representative of the bidder authorized to

execute Bid Proposals, listing each bid document submitted by author, date, nature, and subject matter. The affidavit shall attest 1) that the affiant has personally examined the Bid Documentation, 2) that the affidavit lists all of the documents relied upon by the bidder in preparing the bid for the project, and 3) that all Bid Documentation is included in the sealed container submitted in escrow.

(C) Duration and Use:

Within three days of award of the contract, the Department and the contractor will jointly deliver the sealed container and affidavit to a banking institution or other bonded document storage facility selected by the Department for placement in a safety deposit box, vault, or other secure accommodation.

The document depository agreement shall reflect that the Bid Documentation and affidavit shall remain in escrow during the life of the contract or until the contractor requests that the Department verify a request for additional compensation or an extension of time based on its bid or unless a court order provides the Department permission to obtain the Bid Documentation. In the absence of such action and provided the contractor signs the final Standard Release Form, the Department will instruct the document depository to release the sealed container to the contractor.

In accordance with the contractor's representation that the sealed container placed in escrow contains all of the materials relied upon in preparing its bid, the contractor agrees to waive the right to use any Bid Documentation other than that placed in escrow in disputes arising out of the contract.

(D) Format and Contents:

Bidders may submit Bid Documents for escrow in the usual cost estimating format. It is not the intention of this specification to cause the bidder extra work during the preparation of the proposal, but to ensure that the Escrow Bid Documents will be adequate to enable complete understanding and proper interpretation for their intended use. The Bid Documents shall be written in the English language.

It is required that the Bid Documents clearly itemize the estimated costs of performing the work of each bid item contained in the bid schedule. Bid items are to be separated into sub-items as required to present a completed and detailed cost estimate and allow a detailed cost review. The Bid Documents shall include all quantity take-offs, crew, equipment, calculations of rates of production and progress, copies of quotations from subcontractors and suppliers, and memoranda, narratives, consultant’s reports, add/deduct sheets, and all other information included by the bidder to arrive at the prices contained in the bid proposal. Estimated costs shall be broken down into the bidder’s usual estimate categories such as direct labor, repair labor, equipment operation, equipment ownership, expendable materials, permanent

materials, and subcontract cost as appropriate. Plant and equipment and indirect costs are to be detailed in the bidder's usual format. The contractor's allocation of plant and equipment, indirect costs, contingencies, markup and other items to each bid item shall be included.

All costs shall be identified. For bid items amounting to less than $10,000, estimated unit costs are acceptable without a detailed costs estimate, providing that labor, equipment, materials, and subcontracts, as applicable, are included and provided that indirect costs, contingencies, and markups, as applicable, are allocated.

If the Bid Documents were developed using computer generated software, the contractor shall provide the documents in hard copy and shall identify the name and version of the computer software used.

Bid documents provided by the Department need not be included in the Bid Documents for escrow unless needed to comply with the requirements of this subsection.

(E) Refusal or Failure to Provide Bid Documentation:

Failure to provide Bid Documentation shall render the bid non-responsive.

(F) Confidentiality of Bid Documentation:

The Bid Documentation and affidavit in escrow are, and shall remain, the property of the contractor. The Department has no interest in, or right to, the Bid Documentation unless the contractor requests that the Department verify its request for additional compensation or an extension of time based on its bid or unless a court order gives the Department permission to obtain the Bid Documentation. In the event of such requests or court orders, the Bid Documentation and affidavit will become the property of the Department until complete resolution of the reason for the request or court order is achieved. These materials, and all copies made by the Department, will be returned to the contractor at the conclusion of litigation, or final resolution of all outstanding claims, upon execution of a final release. The Department will make every reasonable effort to ensure that the Bid Documentation remains confidential within the Department except that said documents may be used in court, arbitration, or other dispute resolution proceedings. Otherwise, said documents will not be made available to anyone outside the Department.

(G) Cost and Escrow Instructions:

The cost of the escrow documentation depository storage facility will be borne by the Department. The Department will provide escrow instructions to the document depository consistent with this subsection.

(H) Payment:

There will be no separate payment for compilation of the data, providing the container or the cost of verification of the Bid Documentation. All costs shall be included in the overall contract bid price.

SECTION 104 SCOPE OF WORK:

104.01 Intent of Contract:

The intent of the contract is to provide for the construction and completion of the work to the satisfaction of the Department. The contractor shall furnish experienced supervision and labor, and all materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications and terms of the contract.

(A) Covenant of Good Faith and Fair Dealing:

This contract imposes an obligation of good faith and fair dealing in its performance and enforcement.

The contractor and the Department, with a positive commitment to honesty and integrity, agree to the following mutual duties:

(1) Each will function within the laws and statutes applicable to their duties and responsibilities.

(2) Each will avoid hindering the other's performance.

(3) Each will proceed to fulfill its obligations diligently.

(4) Each will cooperate in the common endeavor of the contract.

(B) Partnering:

The Department encourages the foundation of a cohesive partnering with the contractor and its principal subcontractors and suppliers. This partnering is not a legal partnership as defined by Arizona law. Partnering will be structured to draw on the strengths of each organization to identify and achieve reciprocal goals. The objectives are effective and efficient contract performance and completion within budget, on schedule, and in accordance with the contract.

The establishment of a partnering charter on a project will not change the legal relationship of the parties to the contract nor relieve either party from any of the terms of the contract.

Any cost associated with effectuating partnering will be agreed to by the Department and the contractor and will be shared equally between them.

To implement this partnering initiative prior to starting of work in accordance with the requirements of Subsection 108.02 of the specifications and prior to the preconstruction conference, the contractor's management personnel and the District Engineer will initiate a partnering development seminar/team building workshop. The Department and the contractor will make arrangements to determine attendees at the workshop, the agenda of the workshop, its duration, and its location. Persons required to be in attendance will be the Department‘s Construction Supervisor and key project personnel; the contractor's on-site project manager and key project supervision personnel of both the prime and principal subcontractors and suppliers. The project design engineers, FHWA, and key local government personnel will also be invited to attend as necessary. The contractors and the Department will also be required to have Regional/District and Corporate/State level managers on the project team.

Follow-up workshops may be held periodically throughout the duration of the contract as agreed by the contractor and the Department.

104.02 Revisions to the Contract:

The Department reserves the right to revise the contract at any time. Such revisions shall neither invalidate the contract nor release the surety. The contractor agrees to complete the contract as revised. The contractor shall not proceed with work for which a revision to the contract is required without prior approval from the Engineer. Once approval is received, the contractor shall proceed with such direction immediately, whether the Engineer considers that the contract has been revised or not.

It is the contractor's obligation to notify the Engineer in writing that a revision to the contract is necessary and provide such notification in accordance with Subsection 104.03 of the specifications. Whenever the words notice, notification, request, or notify are used in this subsection, such notice or request shall be provided in accordance with the requirements of Subsection 104.03 of the specifications.

The contract may only be revised by Supplemental Agreement. Supplemental Agreements will be issued for the following reasons only:

(A) To accomplish extra work as defined in Subsection 101.02 of the specifications.

(B) If a differing site condition is encountered as described below:

(1) During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing

materially from those indicated in the contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before the site is disturbed and before the affected work is performed.

(2) Upon written notification, the Engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding anticipated profits, will be made and the contract modified in writing accordingly. The Engineer will notify the contractor of the determination whether or not an adjustment of the contract is warranted.

(3) No contract adjustment which results in a benefit to the contractor will be allowed unless the contractor has provided the required written notice.

(4) No contract adjustment will be allowed under this section for any effects caused on unchanged work.

(C) If the work is suspended by order of the Engineer as provided below:

(1) If the performance of all or any portion of the work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the contractor shall submit to the Engineer, in writing, a request for adjustment within seven calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

(2) Upon receipt, the Engineer will evaluate the contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly. The contractor will be notified of the

Engineer's determination whether or not an adjustment of the contract is warranted.

(3) No contract adjustment will be allowed unless the contractor has submitted the request for adjustment within the time prescribed.

(4) No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided or excluded under any other term or condition of this contract.

(D) If there are significant changes in the character of work as provided below:

(1) The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project.

Changes in quantities and alterations shall not invalidate the contract nor release the surety. The contractor agrees to perform the work as altered.

(2) If the alterations or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or, by affecting other work, cause such other work to become significantly different in character, an adjustment, excluding anticipated profit, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the contractor in such amount as the Engineer may determine to be fair and equitable.

(3) If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided in the contract.

(4) The term "significant change" shall be construed to apply only to the following circumstances:

(a) When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction.

(b) When a major item of work, as defined elsewhere in the contract, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any adjusted unit price for an increase in quantity shall apply only to that portion in excess of 125 percent of original contract item quantity. Any adjustment in contract unit price for a decrease in quantity below 75 percent shall apply only to the actual amount of work performed, except that the product of the adjusted unit price and the reduced quantity of work performed shall in no case exceed the product of the original contract unit price and 75 percent of the Bid Schedule quantity.

(E) To revise the contract time in accordance with Subsection 108.08 of the specifications.

If the Supplemental Agreement is to provide for an increase or decrease in the contract price or time, such increases or decreases will be determined in accordance with Subsections 108.08 and 109.04 of the specifications.

104.03 Notification:

(A) As required by these specifications or any time the contractor believes that the action of the Department, lack of action by the Department, or some other reason will result in or necessitate the revision of the contract, the Engineer must be notified immediately. If within two working days the identified issue has not been resolved between the Department and the contractor, the contractor shall provide a written notice. At a minimum the written notice shall provide a description of the nature of the issue, the time and date the problem was discovered, and if appropriate, the location of the issue. After initial written notice has been provided, the Engineer will proceed in accordance with Subsection 104.02 of the specifications. In addition to proceeding in accordance with Subsection 104.02 of the specifications, the Department and the contractor must make every effort to resolve the issue identified in the initial notice through the partnering process. Only if the issue cannot be quickly resolved by the partnering process will it be necessary for the contractor to proceed to the next step in this subsection.

(B) Once the partnering issue resolution process has been exhausted or within seven calendar days of the date of the initial written notice, whichever is sooner, the contractor shall provide in writing the following information to the Engineer:

(1) The date of occurrence and the nature and circumstances of the issue for which initial notice was given.

(2) Name, title, and, activity of each Department representative knowledgeable of the issue.

(3) Identity of any documents and the substance of any oral communication related to the issue.

(4) Basis for an assertion that work required is a change from the original contract work or schedule.

(5) Identity of particular elements of contract performance for which additional compensation may be sought, including:

(a) Pay item(s) that has been or may be affected by the issue.

(b) Labor or materials, or both, that will be added, deleted or wasted by the problem and what equipment will be idled or required.

(c) Delay and disruption in the manner and sequence of performance that has been or will be caused.

(d) Adjustments to contract price(s), delivery schedule(s), staging, and contract time estimated due to the issue.

(e) Estimate of the time within which the Department must respond to the notice to minimize cost, delay, or disruption of issue.

(6) The contractor's written certification, under oath, attesting to the following:

(a) The request is made in good faith.

(b) Supportive data is accurate and complete to the contractor's best knowledge and belief.

(c) The amount requested accurately reflects the contractor's actual cost incurred.

In complying with this request, the contractor shall use the Department's certification form.

(C) The failure of the contractor to comply with the requirements of this subsection constitutes a waiver of entitlement to additional compensation or a time extension.

(D) Within 10 calendar days after the contractor's submission in accordance with subparagraph (B), the Engineer will respond in writing to the contractor to:

(1) Confirm that a supplemental agreement is necessary and, when necessary, give appropriate direction for further performance, or

(2) Deny that the contract has been revised and, when necessary, direct the contractor to proceed with the contract work, or

(3) Advise the contractor that adequate information has not been submitted to decide whether (1) or (2) applies, and indicate the needed information and date it is to be received by the Engineer for further review. The Department will respond to such additional information within 10 calendar days of receipt from the contractor.

104.04 Maintenance of Traffic:

Unless otherwise provided, the road, while being improved, shall be kept open to all traffic by the contractor. When requested by the contractor and approved by the Engineer, the contractor may bypass traffic over an approved detour route. Regardless of whether it is through or local traffic, the contractor shall keep the portion of the project being used by traffic in such condition that traffic will be adequately accommodated. The contractor shall assume maintenance responsibility through the project at the time its operations begin using the highway or interrupt normal traffic operations. The contractor shall also provide and maintain in a safe condition temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms, but the contractor will not be required to remove snow.

Prior to construction, alterations to contract phasing, detours, and Maintenance and Protection of Traffic plans shall be reviewed by the Engineer at the preconstruction conference or a pre-activity meeting based on the contractor’s preliminary schedule and proposed contract phasing.

Before any detour is opened to traffic, the Engineer shall have been satisfied that traffic is able to proceed in a safe manner.

(A) Detours:

When the contract provides for the construction of detours, such detours, including any temporary drainage structures, base, and surfacing materials and accessory features, shall be constructed to the lines and grades established.

When the use of detours is no longer required, any temporary structures and accessory features shall be removed and disposed of and the detour roadways shall be removed and the ground shall be restored, as nearly as practicable, to the condition existing prior to the construction of the detour.

Payment for the construction of detours, their maintenance and their removal will be as specified in the Special Provisions.

(B) Maintenance of Traffic During Suspension of Work For the Winter Season:

It is the responsibility of the contractor to request a suspension of the construction work for the winter season. The request shall be in writing. Prior to or during any suspension of the construction work for the winter season, the contractor shall make passable, place in a maintainable condition and shall open to traffic such portions of the project and temporary roadways or portions thereof as may be agreed upon between the contractor and the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until an order has been issued for the resumption of construction, the maintenance of the temporary route or line of travel agreed upon and all signs will be by and at the expense of the Department. When construction is resumed, the contractor shall replace or renew any work or materials lost or damaged because of such temporary use; shall remove to the extent ordered any work or materials necessary for the temporary maintenance by the Department and shall complete the work in every respect as though its prosecution has been continuous and without interferences. Such work and any additional work caused by such suspension, for reasons beyond the control of the contractor, will be paid for under the respective pay items or in accordance with the requirements of Subsection 109.04 of the specifications.

(C) Maintenance Directed by the Engineer:

The Engineer may determine that work is required to ensure the safety of the traveling public through the project site. If the Engineer orders maintenance for the benefit of the traveling public, the contractor will be paid for such maintenance under the respective pay items or in accordance with the requirements of Subsection 104.02 of the specifications. Work considered under this specification includes, but is not limited to, sweeping, roadway and subgrade repair, safety feature repair, debris removal, repair of pedestrian features, and other work necessary to provide a smooth and safe traveled way. This work will be only that accomplished on portions of the roadway being used by the traveling public prior to construction improvements or after acceptance of a completed portion of the work. However, the contractor shall repair

any damage caused by its operations at no additional cost to the Department.

104.05 Rights in and Use of Materials Found on the Work:

The contractor, with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material determined suitable by the Engineer, as may be found in the excavation. The contractor will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. The contractor shall replace all of that portion of the excavation material so removed and used which was needed for use in the embankments, backfills, approaches, etc., with material acceptable to the Engineer at no additional cost to the Department. No charge for the materials so used will be made against the contractor. The contractor shall not excavate or remove any material from within the highway location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

Unless otherwise directed by the Engineer, the material from any existing structure may be used temporarily by the contractor in the erection of the new structure. Such material shall not be cut or otherwise damaged except with the approval of the Engineer.

104.06 Restoration of Surfaces Opened by Permit:

The right to construct or reconstruct any utility service in the highway or street or to grant permits for same, at any time, is hereby expressly reserved by the Department for the proper authorities of the municipality in which the work is done.

Any individual, firm, or corporation wishing to make an opening in the highway shall secure a permit from the Department. The contractor shall allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the Engineer, the contractor shall make, in an acceptable manner, all necessary repairs due to such openings and such necessary work will be paid for as extra work or as provided in these specifications, and will be subject to the same conditions as original work performed.

104.07 Railway-Highway Provisions:

If the contractor elects to use crossings other than those shown on the project plans or described in the Special Provisions, the contractor shall make arrangements for the use of such crossings.

All work to be performed by the contractor within the railroad right-of-way shall be performed at such times and in such a manner as not to interfere unnecessarily with the movement of trains or traffic upon the track of the railway company. The contractor shall use all care and

precaution in order to avoid accidents, damage or unnecessary delay or interference with the railway company's trains or other property.

104.08 Prevention of Air and Noise Pollution:

The contractor shall control, reduce, remove, or prevent air pollution in all its forms, including air contaminants, in the performance of the contractor's work.

The contractor shall comply with the applicable requirements of A.R.S. 49-401 et seq. (Air Quality) and with the Arizona Administrative Code, Title 18, Chapter 2 (Air Pollution Control).

The contractor shall comply with all local sound control and noise level rules, regulations, and ordinances which apply to any work performed pursuant to the contract.

Each internal combustion engine used for any purpose on the work or related to the work shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated on the work without its muffler being in good working condition.

104.09 Prevention of Stormwater Pollution:

The contractor shall take sufficient precautions, considering various conditions, to prevent pollution of waters of the United States (WOTUS) and groundwater and to comply with the environmental commitments of the project. Any concrete waste shall be properly controlled to prevent overflow or discharge of wastewater from concrete waste management control measures.

Where the project has the potential to discharge pollutants to WOTUS, pollution prevention control measures shall be installed and maintained as approved by the Engineer. Control Measures, as hereinafter referenced, shall be deemed to include control of erosion and mitigation of any resulting sediment. Control Measures may be temporary or permanent.

At least 15 days prior to the start of ground disturbing activities, the contractor shall submit, for the Engineer's approval, a plan for prevention of erosion and pollution which includes all the Control Measures which the contractor proposes to implement during the construction of the project.

Permanent Control Measures shall be performed at the earliest practicable time consistent with good construction practices. Temporary Control Measures are not meant to be performed in lieu of permanent work specified in the contract.

Construction of drainage facilities as well as the performance of other contract work which will contribute to the control of erosion and sedimentation shall be carried out in conjunction with earthwork operations or as soon thereafter as possible.

Except for that approved in writing by the Engineer, the contractor shall perform no clearing and grubbing or earthwork until the contractor's plan for prevention of erosion and pollution has been approved.

If in the opinion of the Engineer, clearing and grubbing, excavation, or other construction operations are likely to create an erosion problem because of the exposure of erodible earth material, the Engineer may limit the surface area to be disturbed until satisfactory control measures have been accomplished.

The Engineer may order the contractor to provide immediate measures to control erosion and prevent pollution.

At any time the contractor proposes to change its schedule of operations, the contractor shall review and update its plan for prevention of erosion and pollution and submit it to the Engineer for approval.

The contractor shall not be entitled to additional compensation or an extension of contract time for any delays to the work because of the contractor's failure to submit an acceptable plan for prevention of erosion and pollution

Control Measures specified in the contract which are to be accomplished under any of the various contract items will be paid for as specified under those items.

The cost of any Control Measures which may be proposed by the contractor in its plan for prevention of erosion and pollution, in addition to that specified in the contract, will be considered as included in the prices bid for contract items.

104.10 Contractor's Responsibility for Work:

The contractor shall develop a plan for prevention of erosion and pollution for submission to the Engineer outlining the procedures the contractor proposes to use in the control and disposal of stormwater that falls on or flows into the work site. The plan shall include measures to prevent damage to surrounding properties. The contractor shall submit the plan a minimum of 15 calendar days prior to ground disturbing activities.

Until final written acceptance of the project by the Engineer, the contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The contractor shall rebuild,

repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work as specified in Subsection 104.11 of the specifications.

Except as specifically provided under Subsection 104.04(B) of the specifications, in case of suspension of work from any cause whatever, the contractor shall be responsible for the project and shall take such precautions as may be necessary to prevent damage to the project, provide for normal drainage and shall erect any necessary temporary structures, signs or other facilities at no additional cost to the Department.

104.11 Damage by Storm, Flood or Earthquake:

Attention is directed to Subsection 104.10 of the specifications, Contractor's Responsibility for Work. In the event damage to the work is caused by a storm, flood, or earthquake which constitutes an "Occurrence," as hereinafter defined, the provisions of this subsection shall be applicable and the contractor may apply in writing to the Engineer for the State to pay or participate in the cost of repairing damage to the work from such cause or, in lieu thereof, and at the sole discretion of the Department, terminate the contract and relieve the contractor of further obligation to perform the work, subject to the following:

(A) Occurrence:

"Occurrence" shall include:

(1) Tornadoes;

(2) Earthquakes in excess of a magnitude of 3.5 on the Richter Scale at the project site;

(3) Storms and floods for which the Governor has proclaimed a state of emergency, when the damaged work is located within the territorial limits to which such proclamation is applicable; or

(4) Events which constitute catastrophic, unusual, sudden, and unforeseeable manifestation of the forces of nature, the effect of which could not have been prevented or minimized by reasonable human foresight and effort.

(B) Application by Contractor:

The contractor shall immediately begin performing emergency work necessary to provide for the safety and passage of public traffic, and such other emergency work necessary to mitigate damages to the facilities. The contractor's written request for the State to pay or to

participate in the cost of rebuilding, repairing, restoring, or otherwise remedying the damage to the work caused by the occurrence shall be submitted to the Engineer. The repair work may begin prior to authorization by the Engineer, but the contractor shall keep accurate cost records of all such work performed.

(C) Repair Work:

Repair of damaged work under the provisions of this subsection shall be pursuant to a supplemental agreement specifying the repair work to be performed on the damaged facility. Repair work shall consist of restoring the in-place construction (for the purposes of this subsection erected falsework and formwork shall be considered in-place construction) to the same state of completion to which such work had advanced prior to the Occurrence. Emergency work which the Engineer determines would have been part of the repair work if it had not previously been performed, will be considered to be part of said repair work. The Department reserves the right to make changes in the plans and specifications applicable to the portions of the work to be repaired, and if such changes will increase the cost of repairing the damage over the Engineer's estimate of the cost of repair without the changes, the contractor will be paid for such increased costs in accordance with Subsection 104.11(E) of the specifications.

Nothing in this subsection shall be construed to relieve the contractor of full responsibility for the risk or injury, loss, or damage to materials not yet incorporated in the work and to materials, tools, and equipment (except erected falsework and formwork) used to perform the work, nor to relieve the contractor of its responsibility under Subsection 107.13 of the specifications, Responsibility for Damage Claims. The Department will only be responsible for any portion of the work accepted by the Engineer in accordance with Subsection 105.20 of the specifications.

(D) Idled Equipment and Remobilization:

Unless otherwise agreed between the Engineer and the contractor, the cost of the work performed pursuant to this subsection will be determined in accordance with the provisions of Subsection 109.04 of the specifications. The cost of documented direct project costs including idled equipment at stand-by rates, remobilization costs, and direct project office overhead shall be included in the cost of emergency work. The contractor and Engineer will agree on equipment which is idle, inaccessible, unusable, or cannot be relocated to other projects. No profit or overhead will be paid for work covered by this paragraph.

(E) Payment for Repair Work:

The State will pay the cost of the repair work as determined in Subsection 109.04 of the specifications.

(F) Termination of Contract:

If the Department elects to terminate the contract, the termination and the determination of the total compensation payable to the contractor shall be governed by the provisions of Subsection 108.11 of the specifications.

104.12 Environmental Analysis:

The contractor shall prepare an environmental analysis for approval by the Engineer, under any of the following conditions:

(A) If the contractor elects to provide material, in accordance with Section 1001 of the specifications, from a source that involves excavation,

(B) If the contractor elects to use any site to set up a plant for the crushing or processing of base, surfacing, or concrete materials. The contractor may request an exemption from this requirement to provide an environmental analysis if all of the following conditions apply:

(1) The site is exclusively used for the processing of materials,

(2) The site will not be used for excavation of borrow material,

(3) The site was developed as a processing area on or before January 1, 1999,

(4) The site is currently operating as a processing area, and

(5) The plant is located within that portion of the site that was disturbed prior to January 1, 1999.

(C) If the contractor requests that the Engineer approve access to controlled access highway at points other than legally established access points.

The contractor may incorporate an existing environmental analysis approved after January 1, 1999, provided that the analysis is updated as necessary to be in compliance with current regulations and with the contractor's planned activities.

Regulatory changes, specification changes, or other reasons may preclude the approval of a materials source. The contractor acknowledges that the Department may refuse to approve a material source even if the Department had approved the source for other projects.

The environmental analysis shall include all areas of proposed excavation, crushing, processing, and haul roads. For the purposes of Subsection 104.12 of the specifications, a haul road is defined as any road on material excavation, processing, or crushing sites, and any road between the respective site and a public highway that may be used by the contractor.

If the contractor elects to do an environmental analysis and use any site, source, or access for the reasons listed above, they choose to do so at their own risk. It is the contractor's responsibility to exercise due diligence when selecting these sites and areas. The contractor shall bear all costs associated with the use of proposed sites, sources, and accesses.

The contractor shall promptly advise the Engineer that it is preparing the environmental analysis and shall submit to the Engineer for review and consultation. The Department will review the submittal and send it to the appropriate agencies and/or jurisdictions for consultation or return it to the contractor for revision. The contractor shall allow a minimum of 60 calendar days after submittal, or subsequent resubmittals, to the Department for the Department to review the environmental analysis and to consult with the appropriate jurisdictions and/or agencies. At the end of the review period, the Engineer will notify the contractor whether or not the environmental analysis is acceptable.

If the approval of the environmental analysis causes a delay to a controlling activity of the project due to the Department's actions in the aforementioned review process, the contractor may seek, and the Engineer may grant, an extension of time in accordance with the terms of Subsection 108.08 of the specifications. The time extension shall not exceed 30 working days for a working-day contract, or 45 calendar days for a calendar-day project. The time extension will not be considered unless the contractor can show evidence of the delay resulting due to the Department's actions in the review process. A time extension request will not be considered or granted for any other reason. No time extension will be granted for a fixed completion date contract.

The environmental analysis shall address all environmental effects, including, but not limited to, the following:

(A) The location of the proposed source and haul road, and the distance from the source to either an existing highway or an established alignment of a proposed Federal, State, or County highway along with vicinity maps, sketches, or aerial photographs.

(B) The ownership of the land.

(C) The identity and location of nearby lakes, streams, parks, wildlife refuges, or other similar protected areas.

(D) The former use, if known, of the source, and haul road and their existing condition.

(E) The identification of present and planned future land use, zoning, etc., and an analysis of the compatibility of the removal of materials with such use.

(F) The anticipated volume of material to be removed; the width, length, and depth of the excavation; the length and width of the haul road, and other pertinent features and the final condition in which the excavated area and haul road will be left, such as sloped sides, topsoil replaced, the area seeded, etc.

(G) The archaeological survey of the proposed source prepared by a person who meets the Secretary of the Interior's Professional Qualification Standards (48 FR 44716) and possesses a current permit for archaeological survey issued by the Arizona State Museum (ASM). The survey shall be prepared in a State Historic Preservation Office (SHPO) standardized format. The survey shall identify all historic properties within the area of potential effect (APE), as defined by the National Historic Preservation Act (36 CFR 800.4). This includes the materials source, processing area, and the haul road. Additionally, the survey report shall identify the effects of the proposed source on any historic properties within the APE, and recommend measures to avoid, minimize, or mitigate those effects. The survey report shall be prepared by the contractor in accordance with SHPO and ASM formatting style for the Historic Preservation Specialist's initial review. After the initial review, the Department will consult with the landowner, SHPO, and Tribes for a minimum of 35 days for the final approval of the survey report.

(H) If the proposed source and haul road will utilize Prime and Unique Farm land or farm land of statewide importance, a description of such remaining land in the vicinity and an evaluation whether such use will precipitate a land use change.

(I) A description of the visual surroundings and the impact of the removal of materials on the visual setting.

(J) The effect on access, public facilities and adjacent properties, and mitigation of such effects.

(K) The relocation of business or residences.

(L) Procedures to minimize dust in pits and on haul roads and to mitigate the effects of such dust.

(M) A description of noise receptors and procedures to minimize impacts on these receptors.

(N) A description of the impact on the quality and quantity of water resulting from the materials operation shall be provided. The potential to introduce pollutants or turbidity to live streams or nearby water bodies shall be addressed. Measures to mitigate potential water quality impacts shall be coordinated through the EPA for sites located on tribal land, and ADEQ for sites located on non-tribal land.

(O) A description of the impact on federally or state protected or other agency-specific special status wildlife and plants and their habitat, as defined in ADOT's consultant biological procedures on the Department's websites. Compliance with the Arizona Native Plant Law shall be coordinated through the Arizona Commission of Agriculture and Horticulture.

(P) A discussion of the effects of hauling activities upon local traffic and mitigating measures planned where problems are expected.

(Q) A description of the permits required, such as zoning, health, mining, land use, flood plains (see Section 404 of the Clean Water Act), etc.

(R) The effect of removing material or stockpiling material on stream flow conditions and the potential for adverse impacts on existing or proposed improvements within the flood plain which could result from these activities. Measures to mitigate potential water quality impacts shall be coordinated through the EPA for sites located on tribal land, and the ADEQ for sites located on non-tribal land.

Guidance and forms for preparing the environmental analysis are available on the Department's website through the Environmental Planning Group, or by calling Environmental Planning Group at 602-712-7767.

104.13 Value Engineering Proposals by the Contractor:

Proposals may be submitted to the Engineer for modifying the plans, specifications, or other requirements of the contract for the sole purpose of reducing the total costs of construction without impairing in any manner the essential functions or characteristics of the project, including service life, economy of operations, ease of maintenance, benefits to the traveling public, desired appearance or design, and safety standards.

After execution of the contract, an initiative may be recommended by the contractor. The initiative must be identified as a Value Engineering

Proposal (VEP), and may include modifications to the plans or specifications, construction phasing or procedures, or other contract requirements.

Any cost savings generated to the contract as a result of VEP offered by the contractor and approved by the Department will be shared between the contractor and the Department, with the contractor receiving 60 percent and the Department receiving 40 percent, as specified in Subsection 104.13(D) of the specifications.

Bid prices are not to be based on the anticipated approval of a VEP. If a VEP is rejected, the contract shall be completed in accordance with the original terms of the contract or as otherwise modified.

Any decision whether to approve or accept a VEP shall be within the sole discretion of the Department. The Department will bear no liability for any delay in considering a VEP, the refusal to accept or approve such a proposal, or any other matter connected with a VEP.

(A) Submittal and Review of VEP Concept or Idea:

(1) The contractor shall initially submit a brief letter proposal with graphics to the Department to illustrate the concept or idea. The contractor shall indicate whether adequate time is available in its schedule for formal submittal and review prior to VEP implementation.

(2) The Department will review the concept or idea and within 10 days of the contractor's initial submittal and inform the contractor in writing whether the concept or idea has merit and should be submitted as a formal VEP.

(3) If the Department determines that the time for response indicated in the contractor's letter proposal is insufficient for review, the Department may choose to evaluate the need for a noncompensable time extension to the contract. Its evaluation will be based on the additional time needed by the Department for its review and the effect on the contractor's schedule occasioned by the added time. The need for such a time extension will be evaluated in accordance with Subsection 108.08 of the specifications.

(B) Formal Submittal of the VEP:

Within 30 days after the Department has determined the VEP concept or idea has merit, the contractor shall formally submit a proposal. The proposal shall include sufficient data for the Department to make an informed decision regarding the proposal and shall include, at a minimum, the following information:

(1) A statement that the Proposal is submitted as a VEP.

(2) A description of the difference between the existing contract and the proposed change and the advantages and disadvantages of each, including effects on service life, economy of operations, ease of maintenance, benefits to the traveling public, desired appearance, and safety.

(3) A complete set of plans and specifications showing the proposed revisions relative to the original contract features and requirements supported by design computations as necessary for a thorough and expeditious evaluation.

(4) A complete analysis indicating the final estimated costs and quantities to be replaced by the VEP compared to the new costs and quantities generated by the VEP.

(5) A statement specifying the date by which a Supplemental Agreement adopting the VEP must be executed to obtain the maximum cost reduction.

(6) A statement detailing the effect the VEP will have on the time for completing the contract.

(7) A description of any previous use or testing of the VEP and the conditions and results. If the VEP was previously submitted on another Department project, indicate the date, contract number, and the action taken by the Department.

(8) A detailed statement indicating the costs for developing the changes, along with the costs for preparing the value engineering joint proposal.

(C) Conditions:

Value Engineering Proposals will be considered only when all of the following conditions are met:

(1) A VEP, approved or not approved by the Department, applies only to the contract on which it is submitted. A submitted VEP becomes the property of the Department. The VEP shall contain no restrictions imposed by the contractor on its use or disclosure. The Department has the right to use, duplicate, and disclose in whole or in part any data necessary for the utilization of the Proposal. The Department retains the right to use any accepted VEP or part thereof on other projects without obligation to the contractor. This provision is not

intended to deny rights provided by law with respect to patented materials or processes.

(2) If the Department is already considering certain revisions to the contract or has considered or approved changes in the contract of a like nature on other contracts which are subsequently incorporated in a VEP, the Department may reject the VEP and may change the contract without obligation to the contractor.

(3) The contractor shall have no claim for additional costs or delays resulting from the rejection of a VEP, including development costs, loss of anticipated profits, increased material or labor costs except as allowed in Subsection 104.13(D) of the specifications.

(4) The Department will determine if a VEP qualifies for consideration and evaluation. It may reject any VEP that requires excessive time or costs for review, evaluation or investigation, or that is not consistent with the Department's design policies and criteria for the project.

(5) The Engineer will reject all or any portion of work performed under an approved VEP if unsatisfactory results are obtained. The Engineer will direct the removal of rejected work and require construction to proceed under the original contract requirements without reimbursement for rejected work performed under the VEP, or for its removal. Where modifications to the VEP are approved to adjust to field or other conditions, reimbursement will be limited to the total amount payable for the work at the contract bid prices as if it were constructed under the original contract requirements. The rejection or limitation of reimbursement shall not constitute the basis of any claim against the Department for delay or for other costs.

(6) The proposed work shall not contain experimental features but shall contain features that have been used under similar or acceptable conditions on other projects or locations acceptable to the Department.

(7) VEPs will not be considered if equivalent options are already provided in the contract.

(8) The savings generated by the VEP must be sufficient to warrant a review and processing. A savings resulting solely from the elimination or reduction in quantity of a single bid item will not be considered as a VEP. A savings resulting from the elimination or reduction in quantity of a bid item specified as part of a VEP will be considered.

(9) A VEP changing the type of the pavement structure or the type or basic design of a bridge structure will not be considered. Changes in the pavement structural section or in structure design details may be considered with prior approval by the Materials or State Bridge Engineer. Changes to contingency items such as traffic control and dust palliative will not be considered if they are part of pre-determined lump sum contract amounts. Contingency items such as traffic control and dust palliative may be considered when they are reduced as part of a VEP to change scope, method, or procedure, provided they are specified as individual contract bid items.

(10) Additional information needed to evaluate VEPs shall be provided in a timely manner. Untimely submittals of additional information will result in rejection of the VEP. Where design changes are proposed, the additional information could include results of field investigations and surveys, design computations, and field change sheets.

(11) The contractor may submit VEPs for an approved subcontractor. Reimbursement will be made to the contractor. Subcontractors may not submit a VEP except through the contractor.

(12) The contractor shall ensure the VEP is sealed by a Registered Engineer.

(13) The contractor may submit a previously approved VEP from another project.

(D) Acceptance, Rejection and Payment:

Within 30 days of the contractor's formal submission of the VEP, the Department will accept or reject the VEP.

(1) The contractor will be notified in writing by the Engineer as to whether the proposal has been accepted. The decision by the Department is final and shall not be subject to the provisions of Subsection 105.21 of the specifications.

(2) If the VEP is rejected, the Department will share equally in the contractor's costs for developing and presenting the proposal, and the contractor will share equally in the cost to the Department for investigating and evaluating the proposal. A supplemental agreement will be executed to adjust the contract for the net increase or decrease in monies resulting from the contractor's

development costs as listed above in Subsection 104.13(B)(8) of the specifications, and the Department's evaluation costs. The supplemental agreement will terminate the Department's review of the VEP.

(3) If the VEP is accepted in whole or in part, the necessary contract modifications and contract price adjustments will be made by the execution of a supplemental agreement which will specifically state that it is executed pursuant to the provisions of this subsection. The Department will be the sole judge of the acceptability of a VEP and of the estimated net savings in construction costs from the adoption of all or any part of the VEP.

(4) The contractor shall continue to perform the work in accordance with the requirements of the contract until a supplemental agreement incorporating the VEP has been executed, or until the contractor has been given written acceptance or rejection by the Engineer.

(5) The executed supplemental agreement shall incorporate the changes in the plans, specifications, or other requirements of the contract which are necessary to permit the VEP, or such part of it which has been accepted, to be put into effect, and shall include any conditions upon which the Department's approval thereof is based. The executed supplemental agreement shall extend or decrease the contract time if required by the Department.

(6) The executed supplemental agreement shall provide that the contractor be paid 60 percent of the net savings amount as reflected by the difference between the cost of the revised work and the cost of the related construction required by the original contract computed at contract bid prices. The net savings will take into account the contractor’s cost of developing the VEP and implementing the change, and reducing this amount by the Department’s cost for investigating and evaluating the VEP, including any ascertainable collateral costs to the Department. Such collateral costs may include increased costs for maintenance, operation, related work items, additional work items, or elements of related or additional work items.

(7) The executed supplemental agreement shall also provide for the adjustment of contract prices. Contract prices shall be adjusted by subtracting the Department's share of the accrued net savings.

(8) The amount specified to be paid to the contractor in the executed supplemental agreement shall constitute full

compensation to the contractor for the VEP and the performance of the work thereof pursuant to the said supplemental agreement.

104.14 Final Clean Up:

Before final acceptance, the highway, borrow, and local material sources, and all areas occupied by the contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures, and equipment, and all parts of the work shall be left in a condition acceptable to the Engineer.

104.15 Providing Magnetic Detection for Underground Facilities:

(A) General:

All new underground utility facilities, including service connections, placed within ADOT right-of-way by the contractor must be magnetically detectable with standard locating instruments. The contractor shall place continuous detectable tracer wire with all those underground utility facilities that lack a continuous and integral metallic component capable of detection by standard locating instruments.

Tracer wire will not be required for power cables and wires, telephonic or electronic communications (other than fiber optic lines), or for landscape irrigation lines smaller than 2 inches in diameter. For Salt River Valley Water Users Association (S.R.V.W.U.A.) irrigation facilities, no tracer wire will be required if Salt River Project provides their own tracer system.

Tracer wire will be required for non-metallic pipe such as corrugated high density polyethylene plastic pipe (HDPE), steel reinforced high density thermoplastic ribbed pipe, corrugated polypropylene plastic pipe (PP), vitrified clay pipe (VCP), and for polyvinyl chloride pipe (PVC) 2 inches in diameter and larger. Tracer wire will be required where the metallic component is encased within the pipe, such as reinforced concrete pipe (RCP), rubber gasket reinforced concrete pipe (RGRCP), and steel cylinder concrete pipe.

Tracer wire will also be required for non-metallic cable, service connections, and other utility lines; fiber optic lines; empty duct banks and duct banks containing a utility that is not magnetically detectable, either before or after backfilling; and other facilities as determined by the Engineer.

Cast iron and ductile iron pipes may be non-conductive because of site-specific soil conditions or construction configuration; as a consequence all new installations of cast iron and ductile iron pipes shall also be made detectable with tracer wire.

For all other underground facilities, should the magnetic characteristics be unknown, the contractor shall perform sufficient tests with standard locating instruments to determine whether tracer wire will be necessary, and provide the results to the Engineer. Such tests shall be performed prior to construction.

The contractor shall also provide access points, as specified below, for all facilities that will receive tracer wire.

(B) Materials:

Tracer wire shall be solid copper wire, American Wire Gauge (AWG) No. 12 or larger. Tracer wire shall be coated with a minimum 30 mil polyethylene jacket designed specifically for buried use. Tracer wire shall conform to the specifications of the NEC, UL, and other applicable industry standards. Splices as required to promote continuity shall utilize sealed water tight connections.

New access boxes shall be concrete pull boxes in accordance with Subsection 732-2.03 of the specifications (Number 5 Pull Box, Traffic Standard T.S. 1-1), except that the cover shall be marked with the name of the utility or type of facility.

(C) Construction Requirements:

The contractor shall install tracer wire along the top of the entire length of the underground facilities. The tracer wire shall be attached to the facility at minimum intervals of not more than 20 feet, and shall be secured in such a manner that the wire remains firmly attached throughout the construction period.

Tracer wire shall be made accessible along the facility through appropriate pull boxes or other means as approved by the Engineer. New or existing junction boxes or pull boxes included in the construction of conduit or other transmission facilities shall be utilized as access structures wherever possible. For sanitary and storm sewer pipe, tracer wire shall be constructed into the manhole at the pipe entry point, secured to the inside wall along the full length, and be accessible from above upon removal of the manhole cover. For water lines requiring tracer wire, the contractor shall provide access to the wire within the valve boxes. The contractor shall provide and install new access boxes for all tracer wire which cannot be terminated in a new or existing junction or pull box, or new manhole or valve box.

Pull boxes shall be installed flush with the finished grade.

Tracer wire shall be securely attached to the facility at each access point and extended vertically to the access box. The tracer wire shall be terminated with a minimum of 12 inches of slack above the bottom of the pull box.

Tracer wire installed for each segment of underground utility shall be terminated at each access point within the pull box, junction box, manhole, or valve box. The contractor shall make no connections or splices of tracer wire across access points.

New pull boxes installed exclusively for tracer wire shall be placed directly above the utility line in easily reachable areas.

For facilities that cross ADOT right-of-way, tracer wire shall be made accessible at the right-of-way line at approved access points.

For facilities placed longitudinally in ADOT right-of-way, access points shall be located between the right-of-way line and the outside edge of the shoulder or grader ditch, or back of sidewalk or curb and gutter as applicable. Access boxes installed exclusively for tracer wire shall be provided at intervals no greater than 2,000 feet or, as a minimum, at the point each line crosses ADOT right of way. If the utility line is placed outside the preferred location of the access box as described above, the box shall be located in the preferred location and tracer wire shall be installed in a suitable conduit and brought up to the pull box.

For jacking and boring, tracer wire shall be placed inside the jacked sleeve and attached to the utility facility

Empty conduits and duct banks shall have a tracer wire attached to the outside of the facility.

When sanitary sewer force mains are installed in ADOT right-of-way, tracer wire access shall be accomplished by attaching the wire to the outside of wet wells and terminating the wire in pull boxes (Number 5, Traffic Standard T.S. 1-1) placed adjacent to the wet well.

(D) Testing:

The contractor shall test all installed tracer wire, and all those facilities determined to be magnetically detectable without tracer wire, with standard locating instruments to verify conductivity, both before and after backfilling, and provide the results to the Engineer. The contractor shall install new tracer wire for those newly installed utilities that fail to be detectable, at no additional cost to the Department. Tracer wires that fail to test properly shall also be replaced at no additional cost to the Department.

(E) Payment:

No measurement or direct payment will be made for furnishing and installing tracer wires and access boxes, or for testing the installed wires or facilities. Such costs shall be considered as included in the cost of contract items.

104.16 Environmental Standard Work:

(A) General:

This Subsection contains the requirements of environmental standard work applicable to all projects. The contractor shall also comply with all applicable project specific requirements of environmental standard work as specified in the Special Provisions.

(B) General Vegetation Protection Program:

To prevent the introduction of invasive species seeds, all earthmoving and hauling equipment shall be washed prior to entering the construction site and the contractor shall inspect all construction equipment and remove all attached debris, including plant parts, soil and mud, prior to the equipment entering the construction site.

To prevent invasive species seeds from leaving the site, the contractor shall inspect all construction and hauling equipment and remove all debris, including plant parts, soil and mud, prior to leaving the construction site.

The contractor shall provide a letter to the Engineer at the preconstruction conference certifying that the contractor shall comply with the requirements to wash and inspect its equipment to ensure it is free of all debris, including plant parts, soil and mud, prior to arrival at the construction site.

The contractor shall minimize ground disturbance to maintain vegetation in the work and auxiliary areas, such as staging, storage, and stockpiles areas, for the duration of the project to limit noxious or invasive species infestations.

(C) General Clean Water Act Spill Prevention, Control and Countermeasures (SPCC):

If the contractor is using, storing, transferring, or otherwise handling oils (oils, greases, fuel, asphalt cement, asphalt derivatives) at the construction site, the contractor shall take appropriate actions to prevent spills and shall be prepared to take corrective action in case of a spill. Any spills of oils to Waters of the United States (WOTUS) shall be immediately reported to the Engineer. Any other spills of oil, greater than 5 gallons volume shall be reported to the Engineer within 24 hours.

Oil storage containers shall be positioned or located to prevent discharge from the storage site. The storage site shall be located so that it does not conflict with environmental avoidance areas or requirements specified in the contract documents for the project. The contractor shall furnish a secondary means of containment for the entire capacity of the largest single container and sufficient freeboard to contain precipitation from a two-year 24-hour storm. Containment surfaces shall be sufficiently impervious to contain discharged oils.

If the total above-ground storage of all oils as specified in EPA Rule 40 CFR Part 112 is in excess of 1,320 gallons, and where a spill has the potential to reach WOTUS, the contractor shall prepare and implement a project specific SPCC plan. The SPCC plan is required if the total above-ground storage capacity, including mobile re-fuelers stationed on-site, is greater than 1,320 gallons, regardless of the quantity of oils stored within. Containers with capacities less than 55 gallons do not need to be counted towards the total.

The SPCC plan shall meet the requirements of 40 CFR 112 and shall be consistent with applicable federal, state, or local regulations and programs. If the total capacity of the above-ground storage is less than or equal to 10,000 gallons, the contractor may complete the Department's SPCC plan template to prepare the SPCC plan. The template can be found at EPA's website. If the total capacity is more than 10,000 gallons the contractor shall prepare a SPCC plan that is sealed by a professional engineer meeting the requirements of 40 CFR 112.3(d).

The contractor shall submit the SPCC plan to the Engineer at the Preconstruction Conference. The Engineer will review the SPCC plan and return it as approved or rejected within 10 calendar days after receipt and identify any additional items to be included. The contractor shall then modify the SPCC, if necessary, for resubmittal to the Engineer within seven calendar days. The Engineer will review and return each subsequent review within seven calendar days after receipt. No on-site above-ground storage of oils in excess of 1,320 gallons shall commence until the Engineer approves the SPCC Plan for the project and it has been implemented by the contractor.

In coordination with the Engineer, the contractor shall notify EPA as referenced in the SPCC plan, for any spills over 1,000 gallons to navigable waters or two discharges to navigable waters each more than 42 gallons within any 12 month period. Additionally, the contractor shall add a copy of the report with oil spill details to the SPCC Plan documentation for any reportable oil spills. The oil spill details shall include correction actions taken, cause of discharge, and additional preventive measures taken.

A copy of the final SPCC plan, including spill reports, shall be provided to the Engineer within seven calendar days of substantial completion of the project.

(D) Work within Waters of the United States:

The contractor will not be allowed to conduct work within WOTUS that requires a Clean Water Act Section 404 permit unless there is a permit on file with the Department. If a Section 404 permit is on file, the type and the requirements of the permit will be specified in the Special Provisions.

Mechanical equipment shall not be operated in WOTUS unless approved by the Engineer. Any construction activity including, but not limited to, temporary or permanent fill, staging, storing, parking, water disposal, material stockpiling shall not be allowed within WOTUS without a 404 permit allowing the activity.

Should a change of condition require the contractor to work within WOTUS when a permit is not on file, the contractor shall notify the Engineer in writing. After the Department has obtained the Section 404 permit and contractor has received approval from the Engineer, the contractor will be allowed to conduct the permitted scope of work within WOTUS. The contractor shall not conduct work that causes a discharge of dredged or fill material in the WOTUS until a permit is obtained. The Engineer will execute a supplemental agreement to cover the additional work, in accordance with Subsection 104.02 of the specifications.

(E) The Biology Program:

BIO-2A: Migratory Bird Treaty Act:

Although the Department has made a reasonable effort to identify all migratory birds and their nests that require protection in the project area prior to construction, nesting birds may inhabit the construction area and may be found during construction of the project. The contractor shall not harm or harass any migratory birds or their nests. If work occurs during the migratory bird breeding season and active migratory bird nests are found, the contractor shall stop work at that location and notify the Engineer.

The Engineer will direct how to protect the nests and migratory birds. The contractor shall not resume work until it is so directed by the Engineer. In the event of a suspension of work the contractor shall refer to the provisions of Subsection 104.02 of the specifications.

(F) Specific Vegetation Protection Program:

The contractor shall not disturb unpaved areas without the approval of the Engineer or as stated in the Environmental, Permits, Issues, and Commitments (EPIC) plan sheet 1F of the project plans. If any unpaved areas are disturbed as a result of the contractor's operation and without the approval of the Engineer, the contractor shall seed the areas with species native to the project vicinity. All seeded areas shall be covered by straw mulch with tacking agent. The contractor shall provide the seed mix to the Engineer for approval prior to placing any seeding. No measurement or payment will be made for seeding, the cost being considered as included in the price of contract items.

104.17 Archaeological and Cultural Site Protection:

(A) General:

The contractor shall avoid archaeological or cultural sites within the project limits that have been pre-determined and fenced prior to the commencement of construction. The Department will furnish and install a dual-layered fencing system consisting of an outer fence and an inner fence. The outer fence serves as the primary perimeter boundary, providing initial deterrence and control of access, while the inner fence provides an additional layer of security for an archaeological or cultural site. Such pre-determined sites are referred to herein as “fenced cultural avoidance areas”.

For the purposes of this subsection, the term "Disturbance" shall refer to any act of physical disturbance by the operations of the contractor to the fenced cultural avoidance areas. The contractor shall refer to Subsection 104.17(C) specified herein for categories of Disturbance.

The contractor shall exercise utmost care to ensure that the fenced cultural avoidance areas are not disturbed by the operations of the contractor. In addition, the contractor shall comply with the requirements specified in Subsections 107.05, 107.06, and 107.13 of the specifications.

The contractor will not be held liable if the Engineer determines that the Disturbance to the fenced cultural avoidance areas is not due to the actions of the contractor, subcontractor, or supplier.

(B) Archaeological and Cultural Site Protection Plan:

(1) **General:**

The contractor shall prepare a comprehensive Archaeological and Cultural Site Protection Plan, referred to herein as the “Plan”, which shall demonstrate how the contractor intends to avoid potential Disturbances. The Plan, at a minimum, shall contain the following information:

(a) Control measures to be implemented in handling equipment and access of personnel in proximity to the fenced cultural avoidance areas.

(b) Schedule, at a minimum, two weekly walkthroughs, or as determined by the Engineer, for monitoring and inspecting of the fenced cultural avoidance areas.

(c) Name and contact information of the Cultural Compliance Inspector(s).

(d) Proposed oversight of concurrent work activities that take place at more than one location.

The contractor shall submit the Plan at least five working days before the preconstruction conference, provided that the contract is executed

by both the contractor and the Department. The Engineer will return the Plan as approved or disapproved within five working days of receipt. No construction activity shall commence within the project limits until the Plan has been approved.

The contractor shall be aware of the consequences that follow any Disturbance to the fenced cultural avoidance areas throughout the contract duration.

The contractor shall meet with the Engineer, and others as designated by the Engineer, during the preconstruction conference to discuss the following:

(a) Boundaries of the fenced cultural avoidance areas,

(b) Identify and address the potential impacts of the contractor's operations, and

(c) Establish control measures to safeguard fenced cultural avoidance areas from Disturbance

(2) **Cultural Compliance Inspector(s):**

In the Plan, the contractor shall designate employee(s) as Cultural Compliance Inspector(s) to be responsible for implementation of the Plan throughout the contract duration. Any change to designated personnel shall be notified to the Engineer for approval immediately. The Cultural Compliance Inspector(s) shall observe all construction activities in proximity to the fenced cultural avoidance areas and enforce the requirements of the approved Plan to prevent Disturbance.

The Cultural Compliance Inspector(s) shall perform their duties as specified herein. The Cultural Compliance Inspector(s) may perform work in conjunction with site monitoring duties.

The contractor shall complete all the required trainings(s) offered by the Native American Community when specified in the Special Provisions prior to the commencement of any construction activity.

(C) Archaeological and Cultural Site Protection Plan:

(1) **Categories:**

The Disturbance of the fenced cultural avoidance areas are divided into two categories:

(a) A 2nd Degree Disturbance is defined as an intrusion beyond the outer fence. The Engineer will perform an investigation of the incident to make a determination, in consultation with others as is necessary. A 2nd

Degree Disturbance is not considered a violation and is not subject to any sanctions specified herein.

(b) A 1st Degree Disturbance is defined as an intrusion beyond the inner fence that compromises critical parameters, including but not limited to, the security, safety, or integrity of the fenced cultural avoidance area. The Engineer will perform an investigation of the incident to make a determination, in consultation with others as is necessary. An occurrence of a 1st Degree Disturbance will be considered a violation. A 1st Degree Disturbance is subject to the sanctions specified herein.

(2) **Controls:**

The Engineer will coordinate with the ADOT Environmental Planning – Historic Preservation Team to complete the installation of fencing of the cultural avoidance areas. The Engineer will inform the contractor once the fencing installation has been completed prior to the commencement of any construction activity. The Department will assume maintenance responsibility of all items associated with the fencing.

If a Disturbance occurs, the contractor shall immediately stop work at that location. The Cultural Compliance Inspector(s) shall inform the Engineer immediately and document the Disturbance with the following information:

(a) Time and location of the event

(b) Description of construction activity that led up to the event

(c) Details about how the event actually occurred

(d) Names and positions of contractor and subcontractor employee(s) involved

(e) Witness statements, notes, photos, sketches, etc.

Any Disturbance will be investigated by the Engineer in consultation with others as is necessary. Upon completion of such investigation, a determination will be made as to whether the disturbance is a 2nd Degree Disturbance or 1st Degree Disturbance.

Both 2nd Degree and 1st Degree Disturbance will require the contractor to prepare and submit to the Engineer, for approval, an action plan that will prevent similar future incursions.

The contractor shall not resume work at that location until it is so directed by the Engineer.

(D) Sanctions:

The Department will assess sanctions, for each violation, in accordance with the requirements specified below.

1. For the first violation committed by the contractor, the Department will retain monies becoming due the contractor as sanctions as shown in Table 104.17-1:

TABLE 104.17-1 SANCTIONS FOR 1ST VIOLATION	
Contract Size (Dollars)	**Percent of the Original Contract Amount (%)**
0 to 1,000,000	10
> 1,000,000 to ≤ 5,000,000	5
> 5,000,000	3

2. For the second violation committed by the contractor, the Department will retain monies becoming due the contractor as sanctions as shown in Table 104.17-2:

TABLE 104.17-2 SANCTIONS FOR 2ND VIOLATION	
Contract Size (Dollars)	**Percent of the Original Contract Amount (%)**
0 to 1,000,000	12
> 1,000,000 to ≤ 5,000,000	7
> 5,000,000	5

3. A third violation committed by the contractor will result in the termination of the contract in accordance with the applicable requirements of Subsection 108.10 of the specifications.

SECTION 105 CONTROL OF WORK:

105.01 Authority and Responsibility of the District Engineer:

The District Engineer is the State Engineer's direct representative in matters relating to construction activities within a defined area of the state. The District Engineer assigns a Resident Engineer to each of the projects within a District and is responsible to guide each Resident Engineer who administers a contract within the District. The District Engineer will assume the contractual responsibilities of the Resident Engineer if the position is vacated.

105.02 Authority and Responsibility of the Resident Engineer:

The Resident Engineer is the State Engineer's direct representative in matters relating to construction activities and is responsible for the administration and satisfactory completion of the contract. The Resident Engineer is authorized to determine the acceptability and quality of materials furnished and work performed.

The Resident Engineer is authorized to approve supplemental agreements to the contract. After execution of the contract, the Resident Engineer shall be contacted to resolve all questions pertaining to interpretation of the plans and specifications, alterations of the contract, and contractor compensation.

The Resident Engineer will have the authority to suspend the work in whole or in part due to: failure of the contractor to correct conditions unsafe for the workers or the general public; failure to carry out provisions of the contract; and failure to carry out orders. The Resident Engineer may suspend the work due to adverse weather conditions, conditions considered adverse to the prosecution of the work, or any other condition or reason deemed to be in the public interest.

105.03 Plans and Working Drawings:

The plans will show details of all structures, the lines, grades, typical cross sections of the roadway and the location and design of all structures. The contractor shall keep one set of project plans available at the project site at all times.

The plans shall be supplemented by such working drawings as are necessary to control the work adequately. Working drawings shall be furnished by the contractor and shall include such detailed plans as may be required to control the work adequately and are not included in the plans furnished by the Department.

Working drawings which consist of detailed plans, diagrams, etc. shall not be prepared until the elevations, lengths, geometrics, etc., have been verified with the Engineer.

Working drawings which include drawings for falsework, shoring, soldier piles, and other major temporary support structures shall be prepared by and bear the seal and signature of a Professional Engineer. Minor support structures as defined in Subsection 601-1 of the specifications are exempt from this requirement. Falsework submittals will not be required for single and multiple barrel concrete box culverts with a clear span of 12 feet or less. This exemption does not relieve the contractor of the responsibility for providing adequate and safe falsework systems for these structures.

The contractor's schedule of work shall allow a sufficient period of time for the working drawing approval process as follows:

First Submission:	15 Working days or one working day per drawing, whichever is greater;
Second Submission:	10 Working days or 1/2 working day per drawing, whichever is greater.

The time period as shown above shall be doubled for submittals involving falsework or post-tensioning.

The contractor shall allow a minimum of three months for the review of any working drawing submitted for structures involving railroads.

In the event that the contractor's first submission does not meet ADOT standards for shop detail drawings or engineering design drawings and specifications, as determined by the Department, the entire submission will be returned without review and will be recorded as the first submission, and when resubmitted will be subject to the same time requirements as the first submission.

The contractor shall submit at least one copy of the material submitted to the Engineer directly to the appropriate departmental office in Phoenix so that the time necessary for the required approval may be shortened. The Engineer will specify which departmental office is to receive the copy.

The Department will endeavor to return corrected and/or approved drawings with a minimum of delay. In order to expedite the approval of critical drawings, the contractor should indicate in its submittal the order of preference for review and return of drawings and submit all drawings in the order of their importance.

All working drawings will be reviewed by the Engineer for conformance with the design intent of the contracts. Following the Engineer's review of each submittal of working drawings, the Engineer shall respond in writing to the contractor as follows:

(A) "APPROVED," which means approved for construction, fabrication or manufacture, subject to the provision that the work shall be in accordance with the requirements of the contract. Final acceptance of the work shall be contingent upon such compliance;

(B) "APPROVED AS NOTED," which means unless otherwise noted on the drawings approved for construction, fabrication or manufacture, subject to the provision that the work shall be carried out in compliance with all annotations or corrections indicated and in accordance with requirements of the contract. Final acceptance of work shall be contingent

upon such compliance. If also marked "RESUBMIT," approval as noted is valid, and a corrected submittal of the drawings is required; or

(C) "DISAPPROVED," which means that deviations from the requirements of the contract exist in the submittal such that no work based on such drawings shall be constructed, fabricated, or manufactured. The contractor shall revise the drawing in compliance with the Engineer's annotations and pursuant to all requirements of the contract and shall resubmit the working drawings to the Engineer for another review.

The Engineer's approval of the contractor's working drawings shall not relieve the contractor from responsibility for errors in dimensions, for successful completion of the work, or in conforming with the requirements of the plans and specifications nor for responsibility for damage claims as defined in Subsection 107.13 of the specifications. The contractor shall be responsible for the correctness of its plans and for shop fits and field connections, although the plans may have been approved. Any work done or materials ordered or delivered prior to the approval of such working drawings shall be at the sole risk of the contractor.

All working drawings or prints shall be 22 inches in height and 34 inches in length. There shall be 1 1/4-inch margins on the left and right sides, and 3/4-inch margins on the top and bottom. A blank space, 4 inches wide by 3 inches high, shall be left inside the margin in the lower right hand corner. All drawings shall be made in such a manner that clear and legible copies can be made from them. When half-size copies are required, they shall be provided on standard 11 by 17 inch sheets.

A set of drawings, in a format that allows for suitable reproduction, shall be submitted to the Engineer electronically for review. In addition to the electronic submission, the Engineer may request up to three hard copies. Upon completion of the review, the Engineer will stamp the drawings in accordance with item A, B, or C listed above and return a copy to the contractor. Drawings requiring a resubmittal shall be revised in accordance with the Engineer's annotations, after being verified by the contractor, and resubmitted as described above. This resubmittal process shall continue until all corrections and revisions have been made and are acceptable to the Engineer.

No changes shall be made by the contractor to any working drawing after it has been approved by the Engineer.

The cost of furnishing all working drawings shall be considered as included in the contract unit price for one or more of the contract items.

105.04 Conformity with Plans and Specifications:

SECTION 105

All work performed and all materials furnished shall be in reasonably close conformity to the lines, grades, cross sections, dimensions, and material requirements, including tolerances shown on the plans or indicated in the specifications. The Engineer will determine the limits of reasonably close conformity in each individual case and the Engineer's judgment shall be final and conclusive. Where specific provisions regarding quality control standards are set forth elsewhere in the contract, they shall be controlling.

The Engineer's failure to discover or reject materials or work not in accordance with the contract during the progress of work shall not be considered an acceptance of the work or materials, or a waiver of defects. Neither the failure to properly perform inspections, tests or approvals required by the contract documents nor the activities or duties to the Engineer in the administration of this contract shall relieve the contractor from its obligation to perform the work in strict accordance with the contract.

In the event the Engineer finds the materials furnished, work performed or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work meeting the design purpose has been produced, the Engineer will determine the conditions under which the work will be accepted and allowed to remain in place, unless there are other provisions in the contract that provide for this determination. Where this determination is made by the Engineer, rather than contract provisions, the Engineer will document the basis of acceptance by contract modification. The modification will provide for an appropriate adjustment in the contract price for such work or materials as necessary to support this determination.

In the event the Engineer finds the materials furnished, work performed, or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the plans and specifications and have resulted in work which is not reasonably acceptable, the work or materials shall be removed and replaced or otherwise corrected by the contractor at no additional cost to the Department.

The contractor shall bear all the costs of providing the burden of proof that the nonconforming work is reasonable and adequately addresses the design purpose. The contractor shall bear all risk for continuing with nonconforming work until it is accepted.

The Engineer may impose conditions for acceptance of the nonconforming work. The contractor shall bear all costs for fulfilling the conditions.

The decisions whether the product satisfies the design purpose, whether the nonconforming work is reasonably acceptable, and the conditions for acceptance are within the sole discretion of the Engineer.

105.05 Restricted Performance Specifications:

When the work is performed under a restricted performance specification, the target values specified shall be considered to be the values strived for and from which any deviation is allowed.

It is the intent of the specifications that the materials and workmanship shall be uniform in character and shall conform as nearly as realistically possible to the prescribed target value or to the middle portion of the tolerance range. The purpose of the tolerance range is to accommodate occasional minor variations from the median zone that are unavoidable for practical reasons. When either a maximum and minimum value or both are specified, the production and processing of the material and the performance of the work shall be so controlled that material or work will not be preponderantly of borderline quality or dimension. The Engineer will determine acceptability of materials or construction as outlined in the applicable sections of the specifications.

105.06 Coordination of Plans, Specifications, and Special Provisions:

The Special Provisions, the Plans, the Standard Specifications, and all supplementary documents are essential parts of the contract and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work.

In case of discrepancy or conflict, the order in which they govern shall be as follows:

(A) Supplemental Agreements
(B) Special Provisions
(C) Project Plans
(D) Standard Drawings
(E) Standard Specifications

Where dimensions on the plans are given or can be computed from other given dimensions they shall govern over scaled dimensions.

The contractor shall take no advantage of any error or omission in the plans, estimated quantities, or specifications. In the event the contractor discovers an error or omission, it shall immediately notify the Engineer in accordance with Subsection 104.03 of the specifications.

105.07 Cooperation by Contractor:

The contractor shall give the work the constant attention necessary to facilitate the progress thereof and shall cooperate with the Engineer, the Engineer's Inspectors, and other contractors in every way possible.

The contractor shall have on the work at all times, as the contractor's agent, a competent superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer. The superintendent shall have full authority to execute orders or directions of the Engineer without delay and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. A superintendent shall be furnished irrespective of the amount of work subcontracted.

105.08 Cooperation with Utility Companies:

The Department will notify all utility companies, all pipe line owners or other parties affected and endeavor to have all necessary adjustments of the public or private utility fixtures, pipe lines and other appurtenances within or adjacent to the limits of construction, made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted will be moved by the owners at their expense, unless otherwise provided for in the Special Provisions or noted on the project plans.

The contract will indicate various utility items, some of which will be relocated or adjusted by the utility owner, including the date by which the work is expected to be completed, and other utility items which shall be relocated or adjusted by the contractor.

It is understood and agreed that the contractor has considered in its bid all of the permanent and temporary utility appurtenances in their present or relocated positions as shown on the project plans or described in the Special Provisions.

The contractor shall make every effort to cooperate fully with each utility company and shall understand that delays to its operations may necessarily occur.

If, through the failure of the utility owners to relocate or adjust their facilities as provided for in the contract, the contractor sustains loss which could not have been avoided by the judicious handling of forces, equipment and plant or by reasonable revision in the contractor's schedule of operations, any revisions to the contract price or time will be provided in accordance with Subsections 104.02 and 108.08 of the specifications.

105.09 Cooperation Between Contractors:

The Department reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are awarded within the limits of any one project, each contractor shall conduct its work so as not to interfere with or hinder the progress or completion of the work being performed by other contractors. Contractors working on the same project shall cooperate with each other as directed. If requested by the Engineer, each contractor shall furnish the Engineer with written evidence that the contractor has made the necessary arrangements with the other contractors for the successful prosecution of the work for the benefit of all parties.

Each contractor involved shall assume all liability, financial or otherwise, in connection with its contract and shall protect and save harmless the Department from any and all damages or claims that may arise because of inconvenience, delay or loss experienced by it or other contractors because of the presence and operations of other contractors working within the limits of the same project.

The contractor shall arrange its work and shall place and dispose of the materials being used so as not to interfere with the operations of the other contractors within the limits of the same project and on adjoining projects. The contractor shall join the contractor's work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

105.10 Construction Stakes, Lines, and Grades:

Unless the contract provides for construction survey and layout by the contractor, the Engineer will set construction stakes establishing lines, slopes, and continuous profile grade in road work and center line and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances and will furnish the contractor with all necessary information relating to lines, slopes, and grades. These stakes and marks will constitute the field control by and in accordance with which the contractor shall establish other necessary controls and perform the work.

During the course of construction the contractor shall submit requests for staking. The Department will not be responsible for staking delays unless the Engineer is provided 10 calendar days notice before beginning work on an item and thereafter 48 hours notice that stakes are needed.

When the contractor is aware of errors or suspects that there are errors in the staking, the contractor shall bring them to the attention of the Engineer prior to beginning any work on the basis of the errors. The contractor shall take no advantage of any staking error.

The contractor shall be held responsible for the preservation of all stakes and marks and if any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing them will be charged against it and will be deducted from the payment for the work.

The Department will be responsible for the accuracy of lines, slopes, grades, and other engineering work which it provides under this subsection.

The contractor shall be responsible to maintain all existing monumentation, including section line, right-of-way, and roadway monumentation.

Monumentation disturbed by construction activities shall be re-established at no additional cost to the Department. Monumentation shall be re-established in accordance with Subsection 925-3.02 of the specifications.

105.11 Authority and Responsibility of Project Supervisor and Inspectors:

The primary responsibility of Inspectors is to accurately document the work detailed in the plans and specifications. The documentation will include the level or degree of conformance of the work with the plans and specifications.

The Inspectors are also responsible for requiring conformance with plans and specifications and are authorized to reject work or materials not in conformance with plans and specifications. An Inspector has neither the authority to issue instructions contrary to the plans and specifications nor to alter or waive the provisions of the contract.

The Resident Engineer may appoint a Project Supervisor who will serve as Lead Inspector.

Unresolved contractor and Inspector disputes relative to interpretation of plans and specifications or acceptability of work or materials will be escalated to the Resident Engineer.

105.12 Inspection of Work:

All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection.

The contractor shall schedule its operations to allow a reasonable amount of time for engineering inspection of the work. In most cases, inspection will be completed in eight work hours or less. The contractor

shall not be entitled to additional compensation or an extension of contract time for delay resulting from such inspections. The Engineer shall perform the inspection as expeditiously as possible in order that the work might progress in an orderly and continuous manner.

Additional inspection costs incurred due to contractor errors shall be at no additional cost to the Department.

The contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as directed by the Engineer. After examination, the contractor shall restore said portions of the work to the standard required by the plans and specifications. Should the work thus exposed or examined prove acceptable, payment for uncovering or removal and replacement of the covering or making good of the parts removed will be made in accordance with the requirements of Subsection 104.02 of the specifications. Should the work so exposed or examined prove unacceptable, the uncovering or removal and replacement of the covering or making good of the parts removed, shall be at no additional cost to the Department.

Any work done or materials used without inspection by the Engineer may be ordered removed and replaced at no additional cost to the Department unless the Engineer failed to inspect after having been given a minimum of 48 hours notice in writing that the work was to be performed. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered nor obligate the Engineer to final acceptance.

When any unit of government, political subdivision, utility, or any railroad corporation is to pay a portion of the cost of the work covered by the contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government, political subdivision or any railroad corporation a party to the contract and shall in no way interfere with the rights of either party to the contract.

105.13 Removal of Unacceptable and Unauthorized Work:

All work which does not conform to the requirements of the contract will be considered as unacceptable work unless otherwise determined to be acceptable in accordance with the requirements of Subsection 105.04 of the specifications.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness or any other cause found to exist prior to the final acceptance of the work shall be removed immediately and replaced in an acceptable manner.

No work shall be done without lines and grades having been previously established. Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the project plans or as given,

except as herein specified or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at no additional cost to the Department.

Upon failure on the part of the contractor to comply with any order of the Engineer made under the provisions of this subsection, the Engineer will have authority to cause unacceptable work to be remedied or removed and replaced and unauthorized work to be removed and to deduct the costs from any monies due the contractor.

105.14 Load Restrictions:

The contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the project. A pamphlet, Sizes and Weights of Vehicles and Loads upon Highways, is available from the Department's Motor Vehicle Division. A special permit will not relieve the contractor of liability for damage which may result from hauling of material or moving of equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or the roadway or to any other type of construction will not be permitted. Hauling of materials over the subgrade or the base course or surface course under construction shall be limited as directed by the Engineer. No loads will be permitted on a Portland cement concrete pavement, base or structure before the expiration of the curing period. The contractor shall be responsible for all damage done by the contractor's hauling equipment. In no case shall legal load limits be exceeded unless permitted in writing by the Engineer.

105.15 Maintenance During Construction:

The contractor shall maintain the work during construction and until the project is accepted except as otherwise specified in Subsection 104.04(C) of the specifications.

This maintenance shall constitute continuous and effective work prosecuted day by day with adequate equipment and forces to the end that the roadway or structures are kept in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the contractor shall maintain the previous course or subgrade during all construction operations.

All costs of maintenance work during construction and before the project is accepted shall be considered as included in the contract unit price for one or more of the contract items.

105.16 Failure to Maintain Roadway or Structure:

If at any time the contractor fails to comply with the provisions of Subsection 105.15 of the specifications, the Engineer will immediately notify the contractor of such noncompliance. If the contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the project and the entire cost of this maintenance will be deducted from monies due or to become due the contractor.

105.17 Furnishing Right-of-Way:

The Department will be responsible for the securing of all necessary rights-of-way in advance of construction. Any exceptions will be indicated in the contract.

105.18 Opening Sections of Project to Traffic:

The Engineer may order certain sections of work to be opened to traffic before completion or acceptance of the work. Opening these sections shall not constitute acceptance of the work or waiver of any contract provisions.

On those sections opened to traffic, the cost of maintaining the roadway to accommodate traffic will be at the Department's expense and the contractor will be compensated for costs incurred under Subsection 104.04 of the specifications. The Engineer will decide which maintenance is required. Compensation for additional expense and additional time if any, shall be set forth in a Supplemental Agreement for those sections of the project ordered opened to traffic if the opening is not due to the fault or inactivity of the contractor.

If the contractor is late in completing features of the work according to the contract or progress schedule, the Engineer will give written notification establishing a time period for completing these features. If the contractor fails to complete or make a reasonable effort to complete the work according to the written notification, the Engineer may order all or a portion of the project opened to traffic. The contractor shall not be relieved of liability or responsibility for maintaining the work and shall conduct the remaining construction operations with minimum interference to traffic without additional compensation for the added cost of the work.

Damage to the project that is not attributable to traffic shall be repaired at no additional cost to the Department. The removal of rock or mud slides shall be done on a basis determined by the Engineer before removal.

Damage to the project resulting from a third-party shall be reported to the Engineer. Damages to permanent project features, determined by the Engineer as eligible for payment in accordance with the requirements of Subsection 104.04 of the specifications, will be paid for in accordance with Subsection 109.04 of the specifications.

105.19 Substantial Completion:

The project is substantially complete and liquidated damages will no longer be assessed when all of the following have occurred:

(A) All lanes of traffic of the completed project are finished and accepted and traffic can move unimpeded through the project at the posted speed;

(B) All signage is in place and accepted;

(C) All guardrails, drainage devices, ditches, excavation and embankment have been accepted; and

(D) The only work left for completion is incidental, away from the paved portion of the highway, and does not affect the safety or convenience of the traveling public.

The decision whether the project is substantially complete is within the sole discretion of the Engineer.

105.20 Acceptance:

(A) Partial Acceptance:

If at any time during the prosecution of the project the contractor completes a unit or portion of the project, the contractor may submit a written request to the Engineer to make inspection of that unit. The Engineer will approve or disapprove the request within five working days.

If approved, and the Engineer finds upon inspection that the unit has been satisfactorily completed in compliance with the contract, the Engineer may accept that unit as being completed and the contractor may be relieved of further responsibility for that unit. Such partial acceptance shall in no way void or alter any of the terms of the contract.

(B) Final Acceptance:

Upon notice from the contractor that the entire project is substantially complete, the Engineer will make an inspection. If all construction provided for and contemplated by the contract is found completed to the Engineer's satisfaction, that inspection will constitute the final inspection and the Engineer will make the final acceptance and notify the contractor in writing of this acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory or not complete, the Engineer will give the contractor written notice of the unsatisfactory or incomplete work and

the contractor shall immediately correct such work. In such case, the Engineer will also give the contractor written notice as to whether or not the work is substantially complete. In addition, final acceptance will not be made until all completed plans and working drawings as required in Subsection 105.03 of the specifications have been submitted and deemed acceptable by the Engineer.

Upon completion and correction of the work, as called for by the Engineer's notice, the above procedures will be repeated until the Engineer gives notice of substantial completion and final acceptance, separately or together.

105.21 Administrative Process for the Resolution of Contract Disputes:

The notice provision set forth in Subsection 104.03 of the specifications is a contractual obligation assumed by the contractor in executing the contract. The contractor understands that it will be forever barred from recovering against the Department if it fails to give notice of any act or failure to act, by the Engineer, or the happening of any event, thing, or occurrence, in accordance with Subsection 104.03 of the specifications.

The administrative process for the resolution of disputes is sequential in nature and is composed of the following steps:

Step I. Review by the Resident Engineer;

Step II. Review by the District Engineer;

Step III. Review by the State Engineer.

Except as provided in this subsection, no dispute will be accorded a particular level of review unless the dispute has been reviewed at the preceding level and the contractor rejects the decision in writing within the time period specified.

Unless specifically requested by the Department, the submission of additional information by the contractor at any step of the review process shall cause the process to revert to Step I. If at any step in the process a dispute is resolved, the contractor must sign a supplemental agreement which sets for the resolution of the dispute and includes an unconditional release as to any and all matters arising from the dispute.

The contractor shall also notify the Resident Engineer in writing that all documentation in support of the dispute has been provided to the Resident Engineer and that the administrative review process should begin. No formal action will be taken by the Resident Engineer until this written notification is received. The documentation provided to the Resident Engineer shall serve as the basis for evaluating the contractor's position regarding the dispute throughout the administrative process. As a minimum, the information described in Subsection 104.03

of the specifications must accompany each dispute. If the following information applies, it shall also be provided in addition to the information required by Subsection 104.03 of the specifications:

(A) If the dispute relates to a decision of the Engineer which the contract leaves to the Engineer's discretion or as to which the contract provides that the Engineer's decision is final, the contractor shall set out in detail all facts supporting its contention that the decision of the Engineer was not supported by any evidence.

(B) If additional compensation is sought, the contractor shall submit the exact amount sought broken down into the following categories:

(1) Direct Labor

(2) Direct Materials

(3) Equipment

(4) Job Overhead

(5) General and Administrative Overhead

(6) Subcontractor's Work [broken down as (1), (2), (3) and (4) above]

(7) Other categories as specified by the contractor.

(C) If additional compensation or a time extension is sought, the contractor shall certify the above information in accordance with Subsection 104.03(B)(6) of the specifications.

The Resident Engineer will render a written decision regarding the matter in dispute within 10 calendar days of receipt of the contractor's notification that the dispute resolution process should begin.

The contractor shall, upon receipt of the decision by the Resident Engineer, either accept or reject the decision in writing. If the contractor does not reject the Resident Engineer's decision within 15 calendar days of its receipt, the contractor will be deemed to have accepted the decision, the dispute will be considered withdrawn from the administrative process, and there will be no further administrative remedy.

If the contractor rejects the decision of the Resident Engineer, the dispute will be forwarded by the Resident Engineer to the District Engineer. The District Engineer will, within 15 calendar days of receipt of the dispute information from the Resident Engineer, schedule and

hold a meeting to review the dispute with the contractor. This time limit may be extended by mutual agreement of the parties. The District Engineer will, within 15 calendar days of the meeting, issue a written decision, with justification, regarding the dispute.

The contractor shall, within 15 calendar days of receipt of the decision, either accept or reject it in writing. If the contractor does not reject the District Engineer's decision within 15 calendar days, the contractor will be deemed to have accepted the decision and the dispute will be considered withdrawn from the administrative process and there will be no further administrative remedy.

If the contractor rejects the decision of the District Engineer, the District Engineer will forward the dispute to the State Engineer. The State Engineer will, within 15 calendar days of receipt of the dispute information from the District Engineer, schedule and hold a meeting with the contractor. This time limit may be extended by mutual agreement of the parties. The State Engineer will, within 15 calendar days of the meeting, issue a written decision, with justification, regarding the dispute.

The contractor shall, within 15 calendar days of the receipt of the decision of State Engineer, either accept or reject it in writing. If the contractor does not reject the State Engineer's decision within 15 calendar days, the contractor will be deemed to have accepted the decision, the dispute will be considered withdrawn from the administrative process, and there will be no further administrative remedy.

If the contractor rejects the decision of State Engineer, there will be no further automatic review of the dispute.

(D) The decision of the State Engineer in relation to the contractor's claim shall be final unless the contractor commences arbitration or litigation as follows:

(1) Where the amount in controversy is $200,000 or less, the contractor's sole legal remedy shall be arbitration as prescribed in Subsection 105.22 of the specifications.

(2) Where the amount in controversy is more than $200,000, the contractor’s sole remedy shall be to initiate litigation pursuant to A.R.S. Section 12-821 et seq.

(E) If the contractor is not satisfied with the decision of the State Engineer, and prior to filing for arbitration or litigation, the contractor may request a non-binding mediation by filing a request for mediation in writing with the Engineer. The Engineer will then arrange for a mutually agreeable mediator. Such request for mediation shall be made within 30 calendar

days from the date of the State Engineer's decision as provided for in this subsection.

In connection with the mediation, each party shall bear its own costs, attorneys fees, and expert fees. Any fees and expenses assessed by the mediator shall be borne equally by the parties.

105.22 Arbitration of Claims and Disputes:

If the contractor elects to invoke its right to arbitration, the contractor shall file a Demand for Arbitration in writing with the American Arbitration Association or United States Arbitration and Mediation of Arizona, and serve a copy thereof upon the State Engineer. Such Demand for Arbitration shall be made by the contractor within 30 calendar days of the date of the State Engineer's decision as provided for in Section 105.21 of the specifications above, unless a mediation process is already underway, in which case the Demand for Arbitration shall be made within 30 days of the termination of the mediation process. The scope of the arbitration proceeding shall be restricted and limited to the matters presented to the State Engineer upon which the decision or determination was made and shall include no other matters. All arbitration of claims shall be conducted in Phoenix, Arizona, in accordance with the rules of the arbitration service hearing the dispute.

The decision or award of the arbitrator shall be supported by substantial evidence and, in writing, contain the basis for the decision or award and findings of fact. The decision or award by the arbitrator when made shall be final and nonappealable except as provided in A.R.S. Section 12-1512. Both the contractor and the Department shall be bound by the Arbitration Award for all purposes and judgment may be entered upon it in accordance with applicable law in the Superior Court of Arizona in and for the County of Maricopa.

For the purposes of this subsection, a claim for adjustment in compensation shall mean an aggregate of operative facts which give rise to the rights which the contractor seeks to enforce. That is to say, a claim under this subsection is defined as the event, transaction or set of facts that give rise to a claim for compensation, costs, expenses or damages.

In making a determination whether the amount in controversy is $200,000 or less, the parties shall not consider, quantify or take into account any requested extensions of contract time, or the release or remission of liquidated damages previously assessed, under Subsection 108.08 and 108.09 of the specifications.

Any contractor having a claim, adjustment or dispute for an amount in excess of $200,000 may waive or abandon the dollar amount of any such claim in excess of $200,000 so as to bring the claim, adjustment or dispute within the scope and coverage of this subsection, provided that the amount allowed to any such contractor by the arbitration award shall not exceed $200,000. Various damages claimed by the contractor for a

single claim may not be divided into separate proceedings to create claims within the $200,000 limit.

The claim shall be submitted to a single arbitrator who shall be selected by the parties from a list of arbitrators furnished by the arbitration service. Each party shall alternately strike names from the list until only one name remains. The person whose name thus remains on the list of arbitrators is their first choice, but if that person is not available to serve, the two persons whose names were last stricken are acceptable, with the one whose name was last stricken being the first alternate.

Unless agreed to otherwise, the parties shall select the arbitrator within 10 calendar days after each has received a copy of the list of arbitrators.

Each party to the arbitration shall bear its own costs, attorney fees and expert fees. Any other costs and fees assessed by the arbitration service shall be divided equally between the parties to the arbitration.

SECTION 106 CONTROL OF MATERIAL:

106.01 Source of Supply and Quality Requirements:

The contractor shall furnish all materials required to complete the work, except materials that are designated in the Special Provisions to be furnished by the Department as set forth in Subsection 106.12 of the specifications.

Only materials conforming to the requirements of the specifications shall be incorporated into the work. Materials shall be new except as may be provided elsewhere in the contract. The materials shall be manufactured, handled, and used in a workmanlike manner to insure completed work in accordance with the requirements of the plans and the specifications.

In order to expedite the inspection and testing of materials, the contractor shall notify the Engineer of the contractor proposed sources of materials prior to delivery. At the option of the Engineer, materials may be approved at the source of supply before delivery is started. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the contractor shall furnish materials from other sources.

Whenever water is required on a project, as part of either a process or a product, it shall be free of contaminants which, in the judgment of the Engineer, constitute a health hazard to those individuals employed on the project and to the general public.

Untreated effluent shall not be utilized in any aspect of the work.

106.02 Items of Special Manufacture:

At the preconstruction conference, the contractor shall furnish the Engineer a list of all items of special manufacture or items which are or may be in short supply which will be incorporated into the work. Items of special manufacture shall include, but shall not be limited to, materials and equipment for traffic signal and lighting systems, steel bridge members, precast, prestressed concrete bridge members, structural components for rest areas, compressors, pumps, sewage treatment plants, water treatment plants, and materials related thereto.

The items of special manufacture which have been agreed upon by the Engineer and the contractor shall be ordered by the contractor promptly so that they will be available as required and will not delay the work.

The contractor shall advise the Engineer about the dates of the orders and the dates that the items are expected to be received.

106.03 Blank:

106.04 Tests and Acceptance of Material:

(A) General:

All materials will be inspected, tested and approved by the Engineer prior to incorporation in the work. Any work in which materials not previously approved are used shall be performed at the contractor's risk and may be considered as unauthorized and unacceptable and not subject to the payment provisions of the contract.

Unless otherwise specified in the contract documents, materials will be sampled and tested by a qualified representative of the Department. Copies of all test results will be furnished to the contractor's representative at the contractor's request.

Any laboratory performing sampling and testing for an ADOT project shall be open to unrestricted access for inspection and review by the Department. The laboratory shall provide an adequate amount of enclosed space and be supplied with the proper equipment, facilities, and utilities so that the required testing procedures can be performed. It shall have adequate lighting, ventilation, and means of ingress and egress. The laboratory shall be equipped with heating and cooling equipment capable of maintaining an ambient air temperature of 68 to 78 degrees F. The laboratory and all equipment and facilities therein shall be kept clean and maintained in good working order.

The sampling, testing, and acceptance of materials shall be in accordance with the requirements of the specification, in conjunction with the following:

(1) The ADOT Materials Testing Manual.

(2) The ADOT Materials Practice and Procedure Directives Manual.

(3) Applicable Federal, AASHTO, or ASTM specifications or test designations.

(4) Applicable specifications or test designations of other nationally recognized organizations.

Unless otherwise specified, whenever a reference is made to an Arizona Test Method or an ADOT Materials Practice and Procedure Directive (PPD), it shall mean the test method or PPD in effect on the bid opening date.

Any reference to the ADOT Materials Policy and Procedure Directives elsewhere in the contract documents shall be understood to mean ADOT Materials Practice and Procedure Directives.

Unless otherwise specified, whenever a reference is made to a Federal, AASHTO, or ASTM specification or test designation, or to a specification or test designation of other nationally recognized organizations, it shall mean the specification or test designation in effect on the bid opening date.

(B) Contractor Quality Control:

The contractor is responsible for quality control measures necessary to provide acceptable quality in the production, handling, and placement of all materials. Except as specified below, no payment will be made for such measures, the cost being considered as included in contract items.

Certain construction items may require additional quality control measures, as specified in Subsection 106.04(C) of the specifications. When so specified, the contractor shall provide all the personnel, equipment, materials, supplies, and facilities necessary to obtain samples and perform the tests listed in the applicable section and as given herein in Subsection 106.04(C) of the specifications. Specific contractor quality control requirements will be shown in the applicable construction items. Payment for such additional work shall be in accordance with the requirements of the Contractor Quality Control Item included in the Special Provisions.

When the specifications do not require specific contractor quality control measures, the provisions given in Section 106.04(C) of the specifications do not apply. The Contractor Quality Control Item will not be included in the Special Provisions

(C) Specific Contractor Quality Control Measures:

(1) General:

At the preconstruction conference, the contractor shall designate a qualified employee as Quality Control Manager to be responsible for implementing, monitoring and, as necessary, adjusting the processes to assure acceptable quality. The quality control manager shall be a full time employee of the contractor, and shall be on the project site during all construction activities. Also at the preconstruction conference, the contractor shall be prepared to discuss his understanding of the quality control responsibilities for the specified materials.

When requested by the contractor, the Department will engage in testing of materials for the purpose of correlating the contractor's test results to those of the Department's acceptance laboratory.

(2) Quality Control Laboratory:

All field and laboratory sampling and testing shall be performed by a laboratory or laboratories approved by the Department. The requirements for approval of laboratories are specified in the “System for the Evaluation of Testing Laboratories” directive. Approved laboratories, and the test methods for which they are approved to perform, are listed in the “ADOT Accredited Laboratories” directory. Approved test methods listed in the “ADOT Accredited Laboratories” directory do not include field sampling and testing procedures. When field sampling and testing procedures are performed, the appropriate valid ATTI or ACI certification(s) are required. The “System for the Evaluation of Testing Laboratories” directive and the “ADOT Accredited Laboratories” directory may be obtained on the Department’s website.

The Engineer will promptly advise the contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or sampling and testing personnel and procedures.

(3) Quality Sampling and Testing Supervisor:

The contractor shall designate a Quality Sampling and Testing Supervisor(s) who is responsible to supervise the sampling and testing, and who meets the requirements given in Table 106-1 for the specific material on which sampling and testing is being performed. The Quality Sampling and Testing Supervisor(s) shall be an employee of the contractor or a consultant engaged by the contractor, and may be responsible for supervising the sampling and testing on more than one project. The Quality Sampling and Testing Supervisor(s) shall be able to be at the job site within 24 hours from any point in time. Additional information regarding Quality Sampling and Testing Supervisor certification can be obtained from the ADOT Materials Group, Quality Assurance Section, 1221 North 21st Avenue, Phoenix, Arizona 85009.

TABLE 106-1
QUALITY SAMPLING AND TESTING SUPERVISOR REQUIREMENTS

Soils and Aggregate	
Field	Laboratory

TABLE 106-1
QUALITY SAMPLING AND TESTING SUPERVISOR REQUIREMENTS

Arizona Technical Testing Institute (ATTI) "Field" certification plus one of (A) through (G) below.	Arizona Technical Testing Institute (ATTI) "Laboratory Soils/Aggregate" certification plus one of (A) through (G) below.
Asphaltic Concrete	
Field	Laboratory
Arizona Technical Testing Institute (ATTI) "Field" certification plus one of (A) through (G) below.	Arizona Technical Testing Institute (ATTI) "Asphalt" certification plus one of (A) through (G) below.
Concrete	
Field	Laboratory
American Concrete Institute (ACI) "Concrete Field Testing Technician Grade I" certification plus one of (A) through (G) below.	American Concrete Institute (ACI) "Concrete Strength Testing Technician" certification plus one of (A) through (G) below.

Notes:

(A) Professional Engineer, registered in the State of Arizona, with one year of highway materials sampling and testing experience acceptable to the Department.

(B) Engineer-In-Training, certified by the State of Arizona, with two years of highway materials sampling and testing experience acceptable to the Department.

(C) Obtained a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology, Construction, or related field acceptable to the Department; and with three years of highway materials sampling and testing experience acceptable to the Department.

(D) Certified by the National Institute for Certification in Engineering Technologies (NICET) in the Construction Materials Testing field as an Engineering Technician (Level III) or higher in the appropriate subfield in which sampling and testing is being performed.

(E) Certified by NICET in the Transportation Engineering Technology field as an Engineering Technician (Level III) or higher in the Highway Materials subfield.

(F) Certified by NICET as an Engineering Technician, or higher, in Civil Engineering Technology with five years of highway materials sampling and testing experience acceptable to the Department.

(G) An individual with eight years of highway materials sampling and testing and construction experience acceptable to the Department.

(4) Quality Sampling and Testing Technician:

Quality Sampling and Testing Technicians who perform the actual sampling and testing shall meet the requirements given in Table 106-2 for the specific material on which sampling and testing is being performed. Quality Sampling and Testing Technicians shall be employees of the Quality Control Laboratory and be supervised by a qualified Quality Sampling and Testing Supervisor for the specific material on which sampling and testing is being performed. Additional information regarding Quality Sampling and Testing Technician certification can be obtained from the ADOT Materials Group, Quality Assurance Section, 1221 North 21st Avenue, Phoenix, Arizona 85009.

TABLE 106-2
QUALITY SAMPLING AND TESTING TECHNICIAN REQUIREMENTS

Soils and Aggregate	
Field	Laboratory
Arizona Technical Testing Institute (ATTI)"Field" certification.	Arizona Technical Testing Institute (ATTI)"Laboratory Soils/Aggregate" certification.
Asphaltic Concrete	
Field	Laboratory
Arizona Technical Testing Institute (ATTI)"Field" certification.	Arizona Technical Testing Institute (ATTI) "Asphalt" Certification.
Concrete	
Field	Laboratory
American Concrete Institute (ACI) "Concrete Field Testing Technician Grade I" certification.	American Concrete Institute (ACI) "Concrete Strength Testing Technician" certification.

(5) Records:

The Quality Control Laboratory shall maintain all sampling and testing records and supporting documentation used in the preparation of the Weekly Quality Control Report. Upon request, the contractor shall make those records and supporting documentation available to the Department for review and copying as desired.

Linear control charts shall be maintained by the contractor. Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the upper and/or lower specification limit applicable to each test parameter, and the contractor's test results. The contractor shall use the control charts as part of a process control system for identifying production and equipment problems and for identifying potential pay factor reductions before they occur.

(6) Weekly Quality Control Reports:

The contractor shall submit Weekly Quality Control Reports to the Engineer. The weekly reports shall be complete and accurate, and shall state the types of work, which have been performed during the report period. The report shall also include the process control measures taken to assure quality. The report shall provide sample identification information for materials tested during the report period, including sample number, date sampled, sample location, first and last name of the person obtaining the sample, and original source of material. The report shall also provide the results for all required tests and any retests, corrective actions, and other information relevant to quality control. The report shall include daily diaries for each day of testing, a weekly summary, the project number, and the testing laboratory's project identification number.

Except as stated in the following paragraph, the weekly quality control report shall be prepared using standard forms provided by the Department. The standard forms are available on the Department's website at www.azdot.gov. After accessing the Department's website, select "Business", "Engineering and Construction", "Construction and Materials", "Contractor Information", "Forms and Documents", and then "Weekly Quality Control Forms". Except for the daily diaries, all documentation and information required on the forms shall be typed. Daily diaries may be hand-written if acceptable to the Engineer. The weekly report shall be submitted to the Engineer in paper form with a transmittal letter signed by the contractor's quality control manager.

In lieu of using the standard weekly quality control forms available on the Department's website, the contractor or testing laboratory may prepare the weekly report using proprietary or other software, if acceptable to the Engineer, provided that all required information is included, the format is comparable to the Department's standard format, and the report is submitted in paper form with the required transmittal letter.

The report period shall end at midnight of each Friday, and the report shall be submitted to the Engineer no later than 5:00 p.m. of the following Wednesday. The Engineer will verify that the report is timely, complete, and accurate

Reports that are not submitted by the above-referenced deadline shall be considered delinquent. Reports that are submitted by the above-referenced deadline, but are not complete and accurate, shall also be considered delinquent. In either case, monies shall be deducted from the contractor's monthly estimate in accordance with the requirements for Contractor Quality Control, as specified in the Special Provisions.

106.05 Certificates:

(A) General:

The contractor shall submit to the Engineer an original or copy of either a Certificate of Compliance or a Certificate of Analysis, as required,

prior to the use of any materials or manufactured assemblies for which the specifications require that such a certificate be furnished.

Certificates shall be specifically identified as either a "Certificate of Compliance" or a "Certificate of Analysis".

The Engineer may permit the use of certain materials or manufactured assemblies prior to, or without, sampling and testing if accompanied by a Certificate of Compliance or Certificate of Analysis, as herein specified. Materials or manufactured assemblies for which a certificate is furnished may be sampled and tested at any time, and, if found not in conformity with the requirements of the plans and the specifications, will be subject to rejection, whether in place or not.

Certificates of Compliance and Certificates of Analysis shall comply with the requirements specified herein, the ADOT Materials Testing Manual, and applicable ADOT Materials Practice and Procedure Directives.

(B) Certificate of Compliance:

A Certificate of Compliance shall be submitted on the manufacturer's or supplier's official letterhead, and shall contain the following information:

(1) The current name, address, and phone number of the manufacturer or supplier of the material.

(2) A description of the material supplied.

(3) Quantity of material represented by the certificate (excluding quantities for temporary traffic control devices).

(4) Means of material identification, such as label, lot number, or marking.

(5) A statement that the material complies in all respects with the requirements of the cited specifications. Certificates shall state compliance with the cited specification, such as AASHTO M 320, ASTM C494; or specific table or subsection of the specifications. Certificates may cite both, if applicable.

(6) A statement that the individual identified in item seven below has the legal authority to bind the manufacturer or the supplier of the material.

(7) The name, title, and signature of the responsible individual. The date of the signature shall also be given.

Each of the first six items specified above shall be completed prior to the signing of the certificate as defined in item seven. No certificate will be accepted that has been altered, added to, or changed in any way after the authorized signature has been affixed to the original certificate. However, notations of a clarifying nature, such as project number, contractor, or quantity shipped are acceptable, provided the basic requirements of the certificate are not affected.

A copy or facsimile reproduction of the original certificate will be acceptable; however, the original certificate shall be made available upon request.

(C) Certificate of Analysis:

A Certificate of Analysis shall include all the information required in a Certificate of Compliance and, in addition, shall include the results of all tests required by the specifications.

106.06 Inspection of the Plant:

The Engineer may undertake the inspection of materials at the source. In the event plant inspection is undertaken, the Engineer shall have the cooperation and assistance of the contractor and the producer with whom the contractor has contracted for materials, and the Engineer shall have full entry at all times to such parts of the plant as may be involved in the manufacture or production of the materials being furnished. Adequate safety measures shall be provided and maintained.

The Department reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered and prior to incorporation into the work and to reject all materials which, when retested, do not meet the requirements of the specifications.

106.07 Sampling Device:

All secondary crushers and screening plants used in producing material shall be equipped with a mechanical sampling device or devices that can either be operated from the ground or is accessible to the operator on a platform.

These devices shall be constructed and operated so that they will move at a constant rate across the full width of material and collect a representative sample of the falling column of material from the discharge belt or chute while the plant is in operation. The sampling devices shall be substantially constructed so that a sample weighing up to 100 pounds can be taken.

The sampling devices shall be equipped with necessary attachments to convey the samples to the ground so that they can be safely and conveniently collected.

The sampling devices shall be approved by the Engineer and shall be maintained in a satisfactory working condition so that samples may be taken at any time, as required by the Engineer.

106.08 Proprietary Products, Trade Names and Substitutions:

The contract may contain references to equipment, materials or patented processes by manufacturer, trade name, make, or catalog number.

Such references shall be regarded as establishing a standard of quality, finish, appearance or performance or as indicating a selection based upon compatibility with existing equipment or materials and shall not be construed as limiting selection to a specific item or source.

The use of an alternative or substitute article of equipment, material or process which, for the purpose intended, is of equal quality, finish, appearance, or performance and which is compatible with existing equipment and materials, when required, will be permitted, subject to the following conditions:

(A) No consideration will be given to a request for substitution prior to contract award. After award and in time to permit consideration and approval without delaying work, the contractor shall submit a written request for substitution.

(B) A request for substitution shall include all information necessary for proof of equality and suitability for substitution, including samples for testing, if required. The request for substitution shall meet the stipulations set forth in Subsection 104.13 of the specifications for Value Engineering Proposals.

(C) The Department will evaluate the information submitted, perform tests when necessary and make comparison. The Engineer will then make the final decision as to acceptability of the proposed substitution. The Department will neither be liable for any delay in acting upon any request for substitution nor for any failure to accept any request pursuant to this substitution.

106.09 Storage of Materials:

Materials shall be so stored as to insure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the right-of-way may be used for storage purposes and for the placing of the contractor's plant and equipment, but any additional space required for this purpose shall be provided by the contractor at no additional cost to the Department. Private property

shall not be used for storage purposes without written permission of the owner and lessee and, if requested by the Engineer, copies of such written permission shall be furnished to the Engineer. All storage sites shall be restored to their original condition by the contractor at no additional cost to the Department. This shall not apply to the stripping and storing of topsoil or to other materials salvaged from the work.

106.10 Handling Materials:

All materials shall be handled in such a manner as to preserve their quality and fitness for the work.

Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quality and quantity of materials as loaded and intended for incorporation into the work and the quality and quantity of materials as actually received at the place where they are to be incorporated into the work.

106.11 Unacceptable Materials:

Material not conforming to the requirements of the specifications, whether in place or not, will be rejected and shall be promptly removed from the site of the work, unless otherwise directed by the Engineer. No rejected material, the defects of which have been corrected, shall be returned to the work site until such time as approval for its use has been given by the Engineer.

106.12 Department-Furnished Material:

The contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Department.

Material furnished by the Department will be delivered or made available to the contractor as specified in the Special Provisions.

The contractor shall receive, inventory, store, inspect, protect, distribute, and install Department furnished material unless otherwise specified in the Special Provisions.

The cost of handling and placing all materials after they are delivered to the contractor shall be considered as included in the contract price for the item in connection with which they are used.

The contractor will be held responsible for all material delivered to it. Deductions will be made from any monies due it to make good any shortages or deficiencies, from any cause whatsoever and for any damage which may occur after such delivery, and for any late delivery charges.

106.13 Warranties and Guaranties:

The contractor shall obtain such manufacturer's or producer's warranties or guaranties on all items, materials, electrical or mechanical equipment consistent with those provided as customary trade practice. The form in which such warranties or guaranties are delivered to the contractor shall include the provision that they are subject to transfer to the maintaining agency as named by the Department, and shall be accompanied by proper validation of such fact. Transfer of warranties or guaranties shall occur at the time of final acceptance of the work or equipment by the Department.

In addition, a contractor warranty or guaranty shall be furnished providing for satisfactory in service operation of the mechanical and electrical equipment and related components for a period of six months following project acceptance.

Should any defect develop during this six month period, the malfunction or defect shall be corrected by and at the expense of the contractor, including all labor, material and associated costs.

106.14 Approved Products List:

The Approved Products List is a list of products which have been shown to meet the requirements of these Standard Specifications. The Approved Products List is maintained by the Department and updated monthly. Copies of the most current version are available on the internet from the ADOT Research Center, through its Product Evaluation Program.

The contractor shall verify that any products chosen for use from the Approved Products List are selected from the version which was most current at the time of the bid opening.

Unless otherwise specified in the Special Provisions, products not appearing on the Approved Products List at the time of the bid opening may be used if they meet the requirements of the contract documents.

When the Special Provisions limit product selection to only those listed on the Approved Products List, unlisted products will be considered as a possible equal only if they are submitted for evaluation as follows:

(A) No consideration will be given to a request for approval of an unlisted product prior to contract award. After award, and in time to allow for consideration and testing without delaying work, the contractor shall submit a written request for approval of a new product.

(B) If the contractor wishes to propose multiple products, separate written requests shall be submitted for each

product. All requests must be received within the timeframes specified herein.

(C) The contractor's progress schedule shall indicate when the proposed product is to be used on the project. The schedule shall include time for the Department to evaluate the proposed product and shall demonstrate that there will be no impacts to the critical path. If, in the opinion of the Engineer, the schedule shows that the evaluation and approval timeframe of the proposed product is not reasonable, the Department will not consider the proposed product.

(D) A request for the use of an unlisted product shall include all information necessary to determine that a product is an equal, including samples for testing, if required. Unlisted products will not be entertained as Value Engineering (VE) Proposals.

(E) The Department will evaluate the information submitted, perform tests when necessary and make comparison. The Engineer will then make the final decision as to whether the proposed product is an equal. The Department will neither be liable for any delay in acting upon any request nor for any failure to approve a request pursuant to the use of an unlisted product.

The Department will review the contractor's request for the use of an unlisted product within 21 days of the contractor's submittal and inform the contractor in writing if the request is rejected, approved, or if the Department will take additional time for evaluation and testing. Any additional information needed to evaluate the proposed substitute product shall be submitted in a timely manner. Untimely submittals of additional information shall result in rejection of the proposed substitute product.

The contractor shall not be entitled to additional compensation or an extension of contract time resulting from the Department's acceptance or rejection of a proposed product. Bid prices shall not to be based on the anticipated approval of a proposed product.

106.15 Blank:

106.16 Salvaged Asphaltic Concrete Materials:

The contract may include mandatory uses and optional uses for reclaimed asphaltic concrete (RAP). Mandatory uses may include milled asphaltic concrete for shoulder build-up, or for other project-specific items. Optional uses for RAP, when allowed in the contract, include asphaltic concrete, aggregate bases, and aggregate subbases.

For projects with both mandatory and optional uses for RAP, the contractor shall ensure that sufficient project-generated RAP is available to complete the mandatory item(s), or provide RAP from other sources, acceptable to the Engineer, to complete such mandatory work, at no additional cost to the Department.

SECTION 107 LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC:

107.01 Laws to be Observed:

The contractor shall keep fully informed of all Federal, State, and local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work or which in any way affect the conduct of the work. The contractor shall comply with Drug Free Workplace Act, Americans with Disabilities Act, OSHA, and all other pertinent laws relating to conditions of employment. The contractor shall at all times observe and comply with all laws, ordinances, regulations, orders, and decrees and shall defend, indemnify, and hold harmless the Department and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order or decree, whether by the contractor or by any of his subcontractors or suppliers, or by any of their employees.

In connection with the performance of the work, the contractor shall not discriminate against any employee or applicant for employment because of race, religion, color, age, disability, or national origin. The aforesaid requirement shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay, or other forms of compensation and selection for training, including apprenticeship. The contractor shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Department setting forth the provisions of the nondiscrimination requirements. One or more bulletin boards, large enough to display posters and other information required in the contract shall be erected on the job site before any work is allowed to begin. The location of the bulletin board(s) will be subject to the approval of the Engineer.

The contractor shall also insert the nondiscrimination requirements in all subcontracts.

107.02 Permits, Licenses, and Taxes:

The contractor shall procure all permits and licenses; pay all charges, fees, and taxes; and give all notices necessary and incidental to the due and lawful prosecution of the work.

107.03 Patented Devices, Materials, and Processes:

If the contractor employs any design, device, material or process covered by letters of patent or copyright, the contractor shall provide for such use by suitable legal agreement with the patentee or owner.

The contractor and the surety shall defend, indemnify, and hold harmless the Department, any affected third party or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process or any trademark or copyright and shall indemnify the Department for any costs, expenses, and damages which it may be obliged to pay by reason of any infringement, at any time during the prosecution or after the completion of the work.

107.04 Federal Aid Participation:

When the United States Government pays all or any portion of the cost of a project, the Federal laws and the rules and regulations made pursuant to such laws shall be observed by the contractor and the work shall be subject to the inspection of the appropriate Federal agency.

Participation and inspection shall in no sense make the Federal Government a party to the contract and shall in no way alter the rights of either party to the contract.

107.05 Archaeological Features:

The attention of the contractor is directed to A.R.S. Title 41, Article 4, Archaeological Discoveries, Sections 41-841, et seq., which make it a felony, punishable by a fine and imprisonment, to investigate, explore or excavate on State land, in or on prehistoric ruins, ancient burial grounds, fossilized footprints, hieroglyphics, and all other archaeological features of Arizona without permits from the Arizona State Museum.

Section 6(a) of the Federal Archaeological Resources Protection Act of 1979 specifies that no person may excavate, remove, damage, or otherwise alter or deface any archaeological resource located on public (Federal) lands or Indian lands unless such activity is pursuant to a permit issued under Section 4 of the Act. Violations of this act are considered a felony and are punishable by fine and imprisonment.

Although the Department will make every effort prior to construction to identify all cultural resources in a project area, previously unidentified archaeological materials could be found during the construction of the project. When archaeological, historical, or paleontological features are encountered or discovered during any activity related to the construction of the project, the contractor shall stop work immediately at that location and shall take all reasonable steps to secure the preservation of those features and notify the Engineer.

The Engineer will direct how to protect the features. The contractor shall not resume work until it is so directed by the Engineer. In the event of a suspension of work pursuant to this clause, the contractor shall refer to the provisions of Subsection 104.02 of the specifications.

107.06 Historic Preservation:

The attention of the contractor is directed to A.R.S. Title 41, Chapter 4.2, Historic Preservation, Section 41-861 et seq., which makes it a felony to intentionally possess, sell or transfer any human remain, funerary object or other artifact.

Although the Department will make every effort prior to construction to identify all items that require Historic Preservation in a project area, previously unidentified human remains, funerary objects, or artifacts may be found during the construction of the project. When human remains or funerary objects are encountered or discovered during any activity related to the construction of a project, the contractor shall stop work immediately at that location and shall take all reasonable steps to secure the preservation of those items and notify the Engineer.

The Engineer will direct how to protect the items. The contractor shall not resume work until it is so directed by the Engineer. In the event of a suspension of work pursuant to the clause, the contractor shall refer to the provisions of Subsection 104.02 of the specifications.

107.07 Sanitary, Health, and Safety Provisions:

The contractor shall provide and maintain in a neat and sanitary condition such accommodations for the use of the contractor's employees as may be necessary to comply with the requirements and regulations of the Arizona State Department of Health Services or other authorities having jurisdiction therein.

Attention is directed to Federal, State, and local laws, rules, and regulations concerning construction safety and health standards. The contractor shall not require any workers to work in surroundings or under conditions which are unsanitary, hazardous, or dangerous to their health or safety.

Occupational Safety and Health Standards shall apply at all times. The contractor shall have, in accordance with OSHA requirements, Material Safety Data Sheets (MSDS) available for all applicable materials stored or utilized on the project. Should the contractor fail to follow OSHA regulations, the Engineer may suspend the work by written notice until compliance has been achieved. Any such failure to comply with OSHA regulations shall constitute waiver of any right to claim for such suspended work. If regulations are in conflict, the more strict regulation will apply.

Prior to construction the Department will make a reasonable effort to locate, identify, and remove potentially hazardous or contaminated materials, including underground storage tanks, within a project area. Despite these efforts, some of these materials may still be found during the construction of the project. During construction operations, should material be encountered which the contractor believes to be hazardous or contaminated, the contractor shall immediately do the following:

(A) Stop work and remove all workers within the contaminated area. For life threatening situations, follow the procedures in the Safety Plan, specified in Subsection 107.08 of the specifications.

(B) Barricade the area and provide traffic control, if necessary, to prohibit unauthorized entry.

(C) Notify the Engineer. If the Engineer cannot be reached from throughout the State, contact the Arizona Department of Transportation Operations Center at (602) 257-1563. If the Operations Center cannot be reached, contact the Department of Public Safety (DPS). The contractor shall not resume work in the area suspected to contain hazardous or contaminated materials until approved by the Engineer.

The Department will determine the extent and nature of the hazardous or contaminated area and specify a clean-up plan, if necessary. Once the Department determines the limits of the area affected by the contaminated materials, work may then be resumed for the remaining areas of the project where contamination is determined not to present a significant hazard.

Substantial suspension of work as a result of the discovery of contaminated or hazardous materials within the project limits shall be in accordance with the requirements of Subsection 104.02 of the specifications.

The Department will determine the contractor's qualifications to perform the work specified in the clean-up plan. If the contractor is not qualified to do the work specified in the clean-up plan, the Department will obtain a contractor for cleanup. The Engineer will execute a supplemental agreement to cover the additional work, in accordance with Subsection 104.02 of the specifications.

107.08 Public Convenience and Safety:

(A) General:

The contractor shall at all times conduct its work as to ensure the least possible obstruction to traffic.

The safety and convenience of the general public and the residents along the highway and the protection of persons and property shall be provided for by the contractor in accordance with the requirements of Subsection 104.04 of the specifications.

The contractor shall abide by OSHA Regulations, including, but not limited to, 29 CFR, Part 1926, and 29 CFR, Part 1910, as well as all applicable standards of the U.S. EPA, the ADEQ, and the U.S. Mine Safety and Health Administration (MSHA). The contractor shall maintain a copy of the specified OSHA Standards on the construction site at all times.

The contractor shall furnish and install 72-inch temporary chain link fencing, or approved equal, satisfactory to the Engineer, around all major structure construction areas (i.e., bridges, pumphouses, drop structures, retaining walls, etc.) and around any unattended excavation deeper than 4 feet, with slopes steeper than 1:2 (V:H). Temporary fencing shall completely enclose the referenced construction activity and shall be secured after normal working hours to prevent unauthorized access. Where called for in the plans, new permanent fencing shall be installed as soon as practicable.

Temporary fence materials which are no longer needed to restrict access to the work area may be utilized in constructing permanent fence. Fence materials, which in the opinion of the Engineer are unacceptable due to either appearance or structural defects, shall be replaced with new materials. No direct payment will be made for furnishing or installing temporary fencing. Permanent fencing will be measured and paid under the appropriate bid items.

Unless otherwise approved in writing by the Engineer, open utility trenches shall be limited to 50 feet in length, except for cast-in-place pipe installations, during non-working hours and shall be covered with steel plate in a manner satisfactory to the Engineer.

(B) Safety Plan:

The contractor shall submit a Safety Plan at the preconstruction conference. The contractor may submit the Safety Plan prior to the preconstruction conference but not until the contract is executed by both the contractor and the Department. The Safety Plan shall specify the procedures the contractor will implement to satisfy OSHA and any state occupational safety guidelines related to the worker, as well as the public, in the construction of excavations, structures, and confined air spaces along with all other activities involved in the project. The plan must also address:

(1) Site-specific safety rules and procedures to deal with the types of risks expected to be encountered on the site;

(2) Routine inspection of construction sites to ensure compliance with applicable local, state, and federal safety laws and regulations;

(3) Training of employees in safe practices and procedures;

(4) Availability of first-aid, medical, and emergency equipment and services at the construction site, including arrangements for emergency transportation;

(5) Security procedures to prevent theft, vandalism, and other losses at the construction site; and

(6) Emergency Vehicle Access Plan (EVAP) as detailed herein.

The Safety Plan shall include a list of emergency procedures, phone numbers, and methods of communication for medical facilities, Police, Fire Department, and other emergency services which may become necessary. The contractor shall be responsible for providing First Aid treatment and medical supplies on the project site, in accordance with OSHA 29 CFR, Part 1910, and for producing and maintaining records of any injury-related incidents. The Safety Plan shall include the requirement that all workers must wear OSHA approved hard hats, reflective safety vests or other approved high visibility warning garments, work shoes, and, when appropriate, safety glasses while in construction areas. The Contractor's Project Superintendent or Safety Supervisor shall ensure that visitors comply with the above requirements as appropriate.

The Safety Plan shall include an EVAP. An emergency event is defined as an incident that requires an emergency vehicle to respond.

When an EVAP is included in the project plans, that plan shall govern unless an alternate plan, acceptable to the Engineer, is submitted by the contractor and accepted in writing by the Engineer. If the contractor uses the EVAP provided by the Department, it shall be submitted as part of the Safety Plan. If no EVAP is provided or if the contractor desires to deviate from the EVAP provided in the plans, the contractor shall submit it to the Engineer for approval as part of the Safety Plan. The contractor's EVAP shall be prepared by an individual meeting the qualifications described in Subsection 701-1 of the specifications. Regardless of whether an EVAP is provided by the Department or by the contractor, the EVAP shall be included in the Safety Plan and incorporated into the traffic control plans.

The EVAP shall describe those measures to be implemented during construction to ensure that emergency vehicles have access, at all times and for all phases of construction, within and through the construction site until the project is substantially complete. The EVAP shall delineate

or describe the manner in which access is available, including traffic control devices or alternate emergency vehicle access routes.

The contractor shall communicate the EVAP, and any updates to the plan, to the Engineer for dissemination to area law enforcement and emergency responders.

The contractor shall implement and maintain the project's EVAP until substantial completion. The contractor shall ensure that all personnel, and those of any subcontractors employed by the contractor, are familiar with the plan and their responsibilities for its use.

In the safety plan, the contractor shall designate a competent person as Safety Supervisor to be responsible for implementation of the Safety Plan throughout the contract period. The Safety Supervisor shall be capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and have authority to take prompt corrective measures to mitigate or eliminate them. The Safety Supervisor shall also conduct safety meetings, oversee and maintain safe jobsite conditions, and ensure that emergency procedures, phone numbers, and all applicable OSHA notification posters are conspicuously placed in all work areas.

The Safety Supervisor shall maintain records demonstrating that all workers have sufficient experience to operate their equipment, and have been instructed in the proper operation of the equipment.

The Safety Supervisor shall furnish evidence that crane operators have been instructed in accordance with the requirements of OSHA 29 CFR, Part 1926.550, Subpart N, and 1926.955, Subpart V.

The Safety Plan submitted by the contractor shall include proposed methods to prevent unauthorized persons from gaining access to the work areas.

The Engineer will review the Safety Plan and will either approve the Safety Plan or identify any additional items that need to be included no more than 10 working days after submittal. The contractor shall then modify the Safety Plan, if necessary, for re-submittal to the Engineer within five working days. The contractor shall not commence work until the Safety Plan has been approved, unless authorized by the Engineer.

107.09 Barricades and Warning Signs:

The contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs, and other traffic control devices and shall take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades, and obstructions shall

be illuminated during hours of darkness. Suitable warning lights shall be provided to control and direct traffic properly.

The contractor shall erect warning signs in advance of any place on the project where operations may interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road. No signs, barricades, lights, or other protective devices shall be dismantled or removed without permission of the Engineer.

All signs, barricades, lights, temporary signals, and other protective devices shall conform to the requirements of the Manual of Uniform Traffic Control Devices (MUTCD) and associated Arizona Department of Transportation Supplement (ADOT Supplement).

107.10 Use of Explosives:

When the use of explosives is necessary for the prosecution of the work, the contractor shall exercise the utmost care not to endanger life or property. The contractor shall be responsible for all damage resulting from the use of explosives.

The contractor shall furnish and erect special signs to warn the public of the contractor's blasting operations. Such signs shall be placed at appropriate points within the limits of the project and these signs shall be maintained as to be clearly evident to the public during all critical periods of the blasting operations.

If blasting is to be done involving the use of electric blasting caps, the signs shall include a warning statement that all mobile radio transmitters should be turned off.

In advance of doing any blasting work involving the use of electric blasting caps within 200 feet of any railroad track or structure, the contractor shall notify the railroad company of the locations, date, time and approximate duration of such blasting operations.

The method of use, storing and handling of explosives and liquid inflammable materials shall conform with all State and local laws, regulations and safety codes. All storage places shall be marked clearly and in large letters: DANGEROUS EXPLOSIVES.

Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than 1,000 feet from the road or from any building, camping area, or place of human occupancy.

The contractor shall notify each property owner and public utility company having structures or facilities in proximity to the site of the work of the contractor's intention to use explosives. Such notice shall

be given sufficiently in advance to enable them to take such steps as they may deem necessary to protect their property from damage.

Before any explosives are used, the contractor shall obtain necessary permits from and comply with the requirements of the National Park Service, Forest Service, Bureau of Indian Affairs or other authority having jurisdiction over the area.

107.11 Protection and Restoration of Property and Landscape:

The contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location. Land monuments and property marks shall not be moved by the contractor until directed by the Engineer.

Private mail boxes within the limits of operations shall be temporarily or permanently relocated, as required, by the contractor in such a manner as to permit uninterrupted mail service.

Existing fences, pole lines, signs, buildings, and structures that are to remain in place shall be protected from injury or damage.

The contractor shall be responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in the contractor's manner or method of executing work or at any time due to defective work or materials and the contractor will not be released from said responsibility until the project has been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work or in consequence of the nonexecution thereof by the contractor, the contractor shall restore, at no additional cost to the Department, such property to a condition similar to or equal to that existing before such damage or injury was done, by repairing, rebuilding or otherwise restoring as may be directed or it shall make good such damage or injury in an acceptable manner.

The contractor shall not deface, injure, or destroy trees, shrubs, or cacti except as required to complete the proposed construction. The attention of the contractor is called to the requirements of the Arizona Native Plant Law, A.R.S. Section 3-901, et seq. The contractor shall give the Arizona Department of Agriculture at least 10 days notice prior to any clearing operations.

Native plants as defined by the Statutes shall not be transported from the land or offered for sale without the written permission of the Commission.

Notice shall be sent to:

Assistant Director
Division of Compliance
Arizona Department of Agriculture
State Office Building, Room 414
1688 West Adams Street
Phoenix, Arizona 85007

Materials removed during construction operations such as trees, stumps, building materials, irrigation, and drainage structures, broken concrete and other similar materials shall not be dumped on either private or public property unless the contractor has obtained written permission from the owner or public agency with jurisdiction over the land. Written permission will not be required, however, when materials are disposed of at an operating, public dumping ground.

Under no circumstances shall the disposal of debris from construction operations create a blemish on the landscape. Material which is to be stockpiled or disposed of off-site shall not encroach on running or intermittent streams, or other waters of the U.S. unless the contractor has obtained the appropriate permits in accordance with applicable state and federal regulations.

Hauling outside of slope staked areas will not be permitted except around concrete structures, structural plate pipe and at locations where topographical or other features render it impractical.

Haul routes outside of slope staked areas shall be as short as practical and shall minimize defacement of or injury to landscape features and vegetation. Such haul routes shall be obliterated and the ground restored to a condition similar to or equal to that existing before such hauling was started.

107.12 Forest Protection:

(A) General:

If a project or a material pit is located on land which is under the jurisdiction of the U.S. Department of Agriculture (USDA) Forest Service, the contractor shall comply with all applicable State and Federal laws, Federal rules and regulations, and the requirements of the National Forest in which the work is located.

Throughout this subsection, the term Forest Service Officer is used. This person shall be understood to be the District Ranger or any other person authorized or duly appointed to act in all matters affecting National Forest lands and resources. Forest Service Officers for each project, when applicable, will be specified in the Special Provisions.

The contractor shall comply with the following minimum requirements for activities within the National Forest:

(1) The contractor shall do everything reasonably within the contractor's power to prevent wildland fires and shall not dispose of material by burning without a written permit from the Forest Service.

(2) The contractor shall not cut timber or brush or commence work in any material pit unless a permit to do so has been obtained from the Forest Service.

(3) The contractor shall fully repair all damage caused by its operations and provide maintenance commensurate with the contractor's use of National Forest roads and trails.

(4) The contractor shall fully comply with all requirements regarding air quality.

(B) Fire Plan:

The contractor shall submit a Fire Plan for approval by the Engineer and the Forest Service Officer prior to any construction activities. The contractor shall prepare the Fire Plan considering the details outlined herein.

The following outlines the mutual responsibilities of the Forest Service, the Department and the contractor to ensure effective prevention and prompt suppression of all fires within the right-of-way and other work areas.

(1) General:

Fires discovered by the contractor and its employees shall be promptly reported to the Engineer and the Forest Service Officer. The contractor and its employees shall make reasonable attempts to control and extinguish fire without endangering life of contractor’s personnel or public on any and all fires within the right-of-way and work areas and within a half-mile zone adjacent thereto. Fires shall be attacked promptly so as to control them while they are small. Fires shall not be abandoned until the Forest Service Officer declares the fire to be out or relieves the contractor and its employees.

The contractor shall place its equipment and employees at the disposal of the Forest Service Officer for the purpose of fighting fires in accordance with the approved Fire Plan.

Equipment shall be operated by employees of the contractor. The Forest Service Officer will assume no responsibility toward such equipment for ordinary wear or damage due to negligence, carelessness, or willful misconduct.

(2) Personnel:

The contractor shall designate at least one representative to train and supervise each construction crew and the individuals designated to perform the duties of fire guard for wildland fire prevention, detection, and suppression. Each such representative shall be named in the Fire Plan.

At contractor's discretion, fire guards may be trained to knowledge standards provided by free Federal Emergency Management Agency (FEMA) NWCG S-190 Introduction to Wildland Fire Behavior (fema.gov) and NWCG S-130 Wildland Firefighter Training (fema.gov) or equivalent training.

The contractor shall provide a list of trained fire guards in the Fire Plan, for all activities involving internal combustion engines and where power-driven equipment has been operated during the day.

The fire guards shall constantly perform their duties during the operating hours and for three additional hours after the construction operations ends for the day, when the proposed Fire Precaution Plan is Plan "B" or "C" as specified in Subsection 107.12(B)(14) of the specifications. The additional work hours of the fire guards will be compensated in accordance with the requirements specified in subsection 104.02 of the specifications. The fire guard may perform contract work in conjunction with fire guard duties during operating hours.

Fire guard on one operating area shall satisfy the requirements on adjacent areas if the travel time with available transportation to reach an adjacent area is not in excess of 10 minutes.

Each fire guard shall be physically able, vigilant, and trained to prevent, detect, and report any wildland fires and to promptly and efficiently take suppression action with available required firefighting equipment and personnel on any wildland fire within the project limits. Each fire guard shall be equipped with a vehicle and a fire tool cache consisting of a cache box, two 4-to-5 gallon backpack pumps filled with water, two size 0 shovels in good working condition, two Pulaskis, and two McLeod tools maintained in serviceable condition.

(3) Reimbursement:

Reimbursement to the contractor for equipment utilized, including operators, will be made by the Forest Service in accordance with rates which have been previously negotiated and agreed upon. These rates will be established prior to mobilization of personnel and equipment to be used for the suppression of fires.

The Forest Service will not reimburse the contractor for the suppression of fires started by them.

The contractor, in suppressing fires caused by others, including lightning-caused fires, in work areas or within a half-mile zone of work areas will be reimbursed by the Forest Service for such suppression.

In emergencies, the contractor may be called upon to suppress fires on other National Forest lands outside the normal half-mile zone within the project proximity. The contractor will be reimbursed by the Forest Service for such suppression.

If the Forest Service requests that any equipment be made available on standby status, reimbursement to the contractor will be made at a rate established by negotiation.

The Department's publication, Requirements for the Utilization of the Schedule of Equipment Rental Rates for Equipment Used on Force Account Work, will not be applicable when the contractor's equipment is being utilized under the direction of the Forest Service Officer in the suppression of fires.

(4) Tool Cache:

The contractor shall furnish and maintain, at a minimum, one tool cache where tools are clean of rust and foreign material; with sharp cutting edges; in good working condition; and sanded and tightly fitted handles. A tool cache shall contain five long handled, round point, size No. 0 or larger shovels; five McLeod tools; two double-bit axes; two brushhooks; two backpack sprayers of 3-5 gallon capacity and two Pulaskis with sheaths. These tools are required separate from, and in addition to, the tools required on equipment and tools under the possession of fire guards.

A proper tool mix shall be specified in the project's Fire Plan for approval. Fire tools shall be located in the active operating area of the project or as stated in the approved Fire Plan.

The fire tools shall be used only for suppressing wildland fires. All personnel performing the contractor's operations shall be equipped with at least one approved fire tool.

(5) Vehicles and Construction Equipment:

All passenger carrying vehicles, including light pickup trucks shall be equipped with one long-handled, round-pointed shovel in good working condition, and one ABC chemical fire extinguisher not less than 2-1/2 pounds capacity.

Each internal combustion fuel carrying truck, loader, skidder, heavy truck, tractor or any other type of equipment, including but not limited to, earth moving equipment, shall be provided with one long-handled round-pointed shovel in good working condition, and one 5-1/2 pound capacity ABC dry chemical fire extinguisher.

Shovels and fire extinguishers shall be so mounted as to be readily reached from the ground.

All internal combustion engines, including those on tractors, jammers or any stationary or mobile equipment, shall be equipped with a spark arrester qualified and rated under USDA Forest Services Standard 5100-1a, “Spark Arrester Guide” or the latest revision of Society of Automotive Engineers (SAE) recommended practice J350, "Spark Arrester Test Procedure for Medium Size Engines” unless it is:

(A) Equipped with a turbine-driven exhaust supercharger such as the turbocharger with no exhaust bypass.

(B) A multi-position engine which meets the performance levels set forth in SAE recommended practice J335B, "multi-positioned small engine exhaust fire ignition suppression” as now or hereafter amended.

(C) A passenger carrying vehicle or light truck, or medium truck up to 40,000 GVW, used on roads and equipped with a factory designed muffler and an exhaust system in good working condition.

(D) A heavy duty truck, such as a dump truck, or other vehicles used for hauling, and used only on roads or established accesses and equipped with a factory designed muffler and with a vertical stack exhaust system extending above the cab.

Heavy equipment equipped with an exhaust driven turbocharger in good working order and with no exhaust bypass will qualify. A straight, mechanically driven supercharger does not qualify. Light trucks up to two-ton, pickups, jeeps, and passenger cars shall have effective mufflers and exhaust pipes comparable to the manufacturer's standard equipment installation.

All internal combustion engine driven vehicles and equipment will be inspected by the Forest Service Officer prior to initial operation. All such vehicles and equipment arriving on the work after the initial inspection shall be reported to the Forest Service Officer for inspection prior to operation. All equipment will be inspected periodically after the initial inspection to ensure that spark arresters or turbocharger are in working order. All operators shall submit their equipment to the Forest Service Officer for inspection upon request. Vehicles and equipment not approved for use shall be repaired to meet the requirements specified herein, re-inspected, and approved by the Forest Service Officer prior to use.

All 1975 and later model passenger vehicles and pickups equipped with a catalytic converter shall have a sticker clearly displayed on the dashboard warning the driver of the fire hazard of driving the vehicle

over or parking the vehicle where tall grass or other flammable materials can come in contact with the catalytic converter.

The contractor shall make daily inspections of all internal combustion engines, stationary and mobile, to ascertain that spark arresters and mufflers are whole and effective, and that there are no connections that can leak burning particles.

All crawler tractors, rubber-tired tractors, and equipment with power source that are suitable for wildland fire suppression work, shall be equipped with two factory type headlights and one backup light, or brackets mounted for portable self-contained battery operated lights. These portable lights shall be furnished and maintained by the contractor at a location approved by the Engineer.

Exhaust equipment described in this Subsection, including spark arresters and mufflers, shall be properly installed and constantly maintained in serviceable condition.

(6) Smoking:

There shall be no smoking while working. This requirement applies to those activities which require that work be performed in an uncleared area, such as clearing and fencing operations. Smoking shall be restricted to areas designated by the Forest Service Officer and such areas shall be a minimum of 2 feet in diameter which have been cleared to mineral soil. All smoking material shall be completely extinguished before leaving these areas.

There shall be no smoking when driving on National forest lands except when traveling on a graveled, oiled, or otherwise surfaced road. Smoking material shall be extinguished either in ash trays or on a spot cleared to mineral soil.

All smoking closures or other restrictions which may be put into effect shall be carefully observed.

(7) Power Saws and Power Equipment:

Power saws shall be equipped with an approved and serviceable spark arrester/muffler. The spark arrester shall be maintained in effective working order, meeting either Department of Agriculture, Forest Service Standard 5100.1a or appropriate Society of Automotive Engineers (SAE) recommended practice J335 and J350 [36 CFR 261.52(j)], as revised to the date of the opening of the proposals.

Power saws or power equipment shall be filled only in an area which has been cleared to mineral soil. They shall not be started at the place where they have been filled. Mufflers shall be kept in place at all times and the spark arrester screens shall be checked daily. Broken or burned screens shall be promptly replaced. Power saws and power equipment

shall be moved at least 10 feet from the place of fueling or refueling before use.

Power saw operators shall check the sawdust at each tree felled before leaving to make sure that no fires have been started. Each operator shall carry with their power saw; a size No. 1, long-handled, round-pointed shovel in good working condition; a fuel can; and a chemical pressurized fire extinguisher of not less than eight ounce capacity by weight.

(8) Burning:

No burning of slash, camp refuse, or other debris or any other burning will be permitted without a daily written permit from the Forest Service and a burn permit issued by the ADEQ, Office of Air Quality.

(9) Fires:

No camp or lunch fires will be permitted except in designated, cleared areas approved by the Forest Service Officer. Any request for lunch fires, warming fires or campfires at an area except those which have been approved shall be made in writing to the Forest Service Officer.

No fires will be allowed when the Fire Precaution Plan "C" or "D" as specified in the Subsection 107.12(B)(14) of the specifications is in effect within the project limits.

(10) Campsites, Parking and Storage Areas:

Campsites, parking, and storage areas on Forest lands shall be approved by the Forest Service Officer prior to use.

All campsites shall comply with all applicable Federal, State, County and City statutes and, ordinances concerning safety, health, and sanitation. Sites shall be cleared of brush, litter, grass or other flammable debris for a radius of 50 feet, maintained, and used in accordance with Forest Service regulations in order to keep the danger of fires to a minimum. The layout of buildings, tanks, trailers, sanitary facilities, etc., shall be approved by the Forest Service Officer.

All chimneys shall be equipped with 1/2-inch mesh screen for spark arrestors. Fire extinguishers approved by the Forest Service Officer shall be placed in readily accessible places in campsites and storage areas.

No fires except those as may be approved in writing by the Forest Service Officer will be permitted. When required by the Forest Service Officer, the contractor shall maintain a cleared fire line around campsites. Upon cessation of use of the campsite, the contractor shall clean up and restore the site to a condition satisfactory to the Forest

Service Officer. Such restoration shall give consideration to the minimizing of erosion.

(11) Welding:

Welding shall be done only at sites which have been cleared to mineral soil. An area within 10-foot radius shall be cleared down to mineral soil before the commencement of the welding operations. Immediately following welding and metal cutting operations, and before leaving the site, careful inspections shall be made to detect and extinguish smoldering materials. A round pointed long handle shovel in good working condition, a 5 or 10 gallon container of water with pump, and a 5 pound fire extinguisher shall be available at each welding site.

A fire guard shall remain on duty during the welding process and at least one additional hour after the process is completed. If the additional work hours fall beyond the normal operating hours of the construction work shift, such additional work hours will be compensated in accordance with the requirements specified in Subsection 104.02 of the specifications. Welding is prohibited on projects when the proposed Fire Precaution Plan is "D" as specified in Subsection 107.12(B)(14) of the specifications.

(12) Blasting:

Electric caps shall be required; fuse caps are prohibited. Primer cord shall be understood to be an explosive and not fuse.

(13) Gas and Oil Storage, and Service Areas:

The location of equipment service areas and gas and oil storage shall be approved in writing by the Engineer. All areas shall be cleared of brush, litter, grass or other flammable debris for a radius of 50 feet.

(14) Emergency Fire Precautions:

The emergency fire precautions shall be in accordance with the requirements specified in CT7.22 "Emergency Fire Precautions (5/2008)" and as specified herein.

In case of an emergency, the contractor shall restrict the operations by following the Emergency Fire Precaution Schedule specified herein.

Staged restriction levels will be determined by the Forest Service Officer. The process will be a mix of quantitative and subjective measures considering local conditions and issues when deciding to implement fire restrictions and/or area closures.

In areas where emergency fire precautions are to be followed, the contractor shall provide a fire guard.

EMERGENCY FIRE PRECAUTION SCHEDULE	
FIRE RESTRICTION/CLOSURE "STAGE"	
"STAGED" RESTRICTION LEVELS	**FIRE PRECAUTION PLAN**
NO RESTRICTIONS	A
STAGE I	B
STAGE II	C
STAGE III PARTIAL/FOREST CLOSURE **	C or D
STAGE IV (TOTAL FOREST CLOSURE)	D
RED FLAG WARNING (Issued by National Weather Service)	D

The Fire Precaution Plans are described as follows:

Fire Precaution Plan	Description
A	The contractor shall comply with all the requirements specified in Subsection 107.12 of the specifications.
B	The contractor shall comply with all the requirements specified in Subsection 107.12 of the specifications except designated areas for smoking and warming or cooking fires will require a written permit from the Forest Service.
C	(i) All power tools shall not be used between 9:00 AM and 8:00 PM, except power tools may be used between 9:00 AM and 2:00 PM on areas cleared to mineral soil. (ii) Loading is authorized to continue between 12:00 Noon and 2:00 PM, on areas cleared to mineral soil. (iii) Hauling trucks shall be out of the Construction Area to a surfaced road by 2:00 PM. (iv) All mechanical equipment used for blasting; welding; metal cutting; and clearing and grubbing shall not be used between 12:00 Noon and 8:00 PM. (v) Operations on mineral soil involving road excavation, watering, grading, surfacing, rock crushing, and/or other equipment maintenance may continue with the approval of the Engineer and the Forest Service Officer. No smoking, warming or cooking will be permitted at any time.
D	The contractor shall shutdown all operations; except operations on mineral soil involving road excavation, watering, grading, gravel surfacing, and rock

	crushing may continue with special Forest Service permit.

The Forest Service Officer may adjust this Fire Precaution Plan for local weather conditions within the project limits.

The process to notify any change to the Fire Precaution Plan by the Forest Service Officer to the Engineer shall be discussed at the pre-construction conference or partnering meeting. These changes shall be approved by the Engineer and the Forest Service Officer through a written agreement.

The approved change to the Fire Precaution Plan will be communicated to the contractor by the Engineer through phone, email or in-person immediately and prior to the forthcoming work shift.

Projects which are outside the boundaries of the partial forest closure may continue to operate under Industrial Fire Precaution Plan “C” operating criteria as agreed upon between the Forest Service Officer and the Engineer in writing.

Projects within the boundaries of the proclaimed partial forest closure area shall operate under Fire Precaution Plan “D”.

107.13 Responsibility for Damage Claims:

The contractor shall indemnify, defend, and hold harmless the State of Arizona, acting by and through the Arizona Department of Transportation, from any and all claims, demands, suits, actions, proceedings, loss, cost and damages of every kind and description, including any attorneys' fees and/or litigation expenses, which may be brought or made against or incurred by the Department on account of loss of or damage to any property or for injuries to or death of any person, to the extent caused by, arising out of, or contributed to, by reasons of any alleged act, omission, professional error, fault, mistake, or negligence of the contractor, its employees, agents, representatives, or subcontractors, their employees, agents, or representatives in connection with or incident to the performance of the work, or arising out of Workmen's Compensation claims, Unemployment Compensation claims, or Unemployment Disability Compensation claims of employees of the contractor and/or its subcontractors or claims under similar such laws or obligations. The contractor's obligation under this subsection shall not extend to any liability to the extent caused by the negligence of the Department, or its employees, except the obligation does apply to any negligence of the contractor which may be legally imputed to the Department by virtue of its ownership or possession of land.

The contractor shall indemnify, defend, and hold harmless any county, town, or incorporated city, its officers and employees, within the limits

of which county, town, or incorporated city work is being performed, all in the same manner and to the same extent as provided above.

107.14 Insurance:

Prior to the execution of the contract, the contractor shall file with the Department a certificate or certificates of insurance evidencing insurance as required by this contract has been placed with an insurer authorized to transact insurance in the State of Arizona pursuant to A.R.S. Title 20, Chapter 2, Article 1, or with a surplus lines insurer approved and identified by the Director of the Department of Insurance pursuant to A.R.S. Title 20, Chapter 2, Article 5.

All insurers shall have an "A.M. Best" rating of A- VII or better.

The State of Arizona in no way warrants that the above-required minimum insurer rating is sufficient to protect the contractor from potential insurer insolvency.

The contractor's submission of the required insurance certificates constitutes a representation to the Department that:

(A) The contractor has provided a copy of these specifications to every broker who has obtained or filed a certificate of insurance and has communicated the necessity of compliance with these specifications to the broker; and

(B) To the best of the contractor's knowledge, each certificate of insurance and each insurance coverage meets the requirements of these specifications.

The contractor shall provide the Department with certificates of insurance (ACORD form or equivalent acceptable to the State of Arizona) as required by the contract. The certificates for each insurance policy shall be signed by a person authorized by that insurer.

Without limiting any liabilities or any other obligations of the contractor, the contractor shall provide and maintain, if commercially available, the minimum insurance coverage listed below until all obligations under this contract are satisfied:

(A) General Liability insurance with a minimum combined single limit of $1,000,000 each occurrence applicable to all premises and operations, and a minimum general aggregate limit of $2,000,000. The policy shall include coverage for bodily injury, broad form property damage (including completed operations), personal injury (including coverage for contractual and employee acts), blanket contractual, independent contractors, products and completed operations. Further, the policy shall include coverage for the hazards commonly referred to as XCU (explosion, collapse

and underground). The products and completed operations coverage shall extend for one year past acceptance, cancellation or termination of the work. The policy shall contain a severability of interests provision.

(B) Comprehensive Automobile Liability insurance with a combined single limit for bodily injury and property of not less than $1,000,000 each occurrence with respect to contractor's owned, hired, or non-owned vehicles, assigned to or used in performance of the work.

(C) Workers' Compensation insurance to cover obligations imposed by Federal and State statutes having jurisdiction of its employees engaged in the performance of the work, and Employers' Liability insurance with a minimum limit of $1,000,000. Evidence of qualified self-insured status will suffice for this subsection.

The insurance policy may not have any deductible amounts with respect to the coverage of the Department, except that the Department may approve a deductible amount if the Department has approved the contractor as a self-insurer with respect to the deductible amount, and the contractor has agreed in writing that its self insurance will extend to the deductible amount prior to any other matters.

The policies required by (A) and (B) above shall be endorsed to include the Department, its agents, officials, employees, and the State of Arizona as additional insureds with respect to any negligence of the contractor which may be legally imputed to the Department or State, and shall stipulate that the insurance afforded the contractor shall be primary insurance and that any insurance carried by the Department, its agents, officials, employees, or the State of Arizona shall be excess and not contributory insurance to that provided by the contractor, as provided by A.R.S. Section 41-621(C).

All insurance policies or certificates shall include a requirement providing for 30 days prior written notice to the Department of any cancellation or reduction of coverage. The contractor shall immediately notify the Department and shall cease operations on the occurrence of any such cancellation or reduction and shall not resume operations until the required insurance is in force and new certificates of insurance have been filed with the Department.

The certificate(s) of insurance shall be issued to the Department by the contractor's insurer as evidence that policies providing the required coverages, conditions and limits are in full force and effect. Certificates of insurance shall be addressed as follows:

Arizona Department of Transportation
Contracts and Specifications Group
205 South 17th Avenue, MD 121F
Phoenix, Arizona 85007

Failure on the part of the contractor to produce or maintain required insurance shall constitute a material breach of contract upon which the Department may immediately terminate the contract or, at its discretion, produce or renew such insurance and pay any and all premiums in connection therewith, and all monies so paid by the Department shall be repaid by the contractor to the Department upon demand, or the Department may offset the cost of the premiums against any monies due to the contractor from the State.

The cost of coverage will be considered as included in the contract price. Costs for coverage maintained by the contractor in excess of those required shall not be charged to the Department.

The Department reserves the right to request and receive certified copies of any or all of the above policies and/or endorsements.

The contractor and its insurers providing the required coverages shall waive all rights of recovery against the Department and its agents, officials and employees.

107.15 Contractor's Responsibility for Utility Property and Services:

(A) General:

The contractor's attention is directed to the requirements of A.R.S. Section 40-360.21 through .29 requiring all parties excavating in public streets, alleys, or utility easements to first secure the location of all underground facilities in the vicinity of the excavation.

The contractor shall review copies of existing ADOT permits, subject to availability, prior to start of construction, to assist the contractor in determining the location of any utilities, which the Department may have record of and which are not otherwise shown on the contract documents. Utility locations obtained from the Department are for information only and shall not relieve the contractor of responsibility for identifying, locating, and protecting any existing utility lines. Copies of permits may be obtained from the ADOT Area Permit Supervisor in the District in which a project is located.

The contractor shall contact the owners of the various utilities prior to the start of construction and shall obtain from them any information pertaining to existing utilities that will either supplement information shown on the project plans or will correct any such information that may be incorrect. The contractor shall furnish the Engineer with evidence that the contractor has contacted the utility companies. Such evidence shall be submitted at the preconstruction conference, and shall include a copy of the information received from each utility as a result of such contacts.

If the contractor learns from either the owner of the utility or from any other source of the existence and location of properties of railway, telegraph, telephone, fiber optics cable, water, sewer, septic tanks or systems, electric, gas and cable television companies either omitted from or shown incorrectly on the project plans, the contractor shall immediately notify the Engineer and shall not disturb the utilities. Relocation or adjustment of such utilities, if deemed necessary, will be either performed by others or shall be performed by the contractor in accordance with the provisions of Subsection 104.02 of the specifications.

The contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication of rearrangement work may be reduced to a minimum and that services rendered by these parties will not be unnecessarily interrupted.

Temporary or permanent relocation or adjustment of any utility line or service connection desired by the contractor for its convenience shall be its responsibility. The contractor shall obtain the approval of both the Engineer and the utility company and upon approval shall make all necessary arrangements with the utility company and shall bear all costs in connection with such relocation or adjustment. The contractor shall also submit a Sewer Discharge Prevention Plan, as specified in Subsection 107.15(C)(1) of the specifications, describing each anticipated relocation or adjustment involving existing sanitary sewer lines. No work on a particular facility shall begin until all approvals for that facility have been received.

The contractor shall be ADOT's underground utility field locator, and perform all requirements as prescribed in A.R.S. Section 40-360.21 through .29, for all underground facilities that have been installed by the contractor on the current project, until the project is accepted by ADOT.

At least two working days prior but no more than 15 working days prior to commencing excavation, the contractor shall contact ARIZONA 811, between the hours of 6:00 a.m. and 5:00 p.m., Monday through Friday, excluding holidays, for information relative to the location of buried utilities. The contractor can call 811 from anywhere in Arizona or can contact ARIZONA 811 at the number below:

Projects In Maricopa County (602) 263-1100

Projects Outside Maricopa County (800) 782-5348

Contractors can also create and manage utility locate tickets online by using the Arizona 811 E-Stake tool at www.Arizona811.com.

(B) Contractor Qualifications for Water and Sewer Lines:

Breakage of active sanitary sewer lines may result in the potential spread of disease, contamination of the site and any adjacent bodies of water, and other hazards to the public. Substantial cleanup costs may be associated with such breakage, as well as possible major civil and/or criminal penalties. Therefore, the Engineer will closely consider the qualifications of any personnel proposed by the contractor to oversee or perform work involving active sanitary sewer lines. The contractor shall not assume that the personnel assigned to perform such work will be acceptable to the Department merely because they meet the experience requirements listed herein.

The contractor, or the subcontracting firm assigned to perform the water and sewer work, shall have a minimum of five years of experience in the installation and construction of underground large diameter (18 inch or above) water and sewer improvements.

In addition, the key personnel assigned by the contractor to perform any work on water or sewer lines, whether from the prime contractor or a subcontracting firm, shall also have at least five years of experience in the installation and construction of underground large diameter (18 inch or above) water and sewer improvements. A minimum of two such people shall be designated by the contractor. The designated personnel may have the title of foreman or superintendent; however, at least one of these people shall be present at all times at the location of any work being performed at or near an active sanitary sewer line.

For both the firm and the key personnel, the experience shall include working with and around water and sewer utility lines that are in service. The contractor shall submit the following documentation to the Engineer for review and approval:

(1) A list indicating that the designated key project personnel have at least five years of applicable experience, as specified above. The list shall be accompanied with resumes for each of the key people. The resumes shall include the following information, and demonstrate compliance with the specified requirements:

    (a) Detailed relevant experience for a minimum of two projects, including project description, date of work, actual work performed by the individual, and references (a minimum of one for each project);

    (b) Level of applicable formal training; and

    (c) Number of years of relevant experience in performing like construction.

(2) A list of water and sewer construction projects completed by the firm performing the water or sewer work, as specified above, indicating a minimum of five years of

applicable experience. Include the dates of work, type of work, description of the project, amount of work performed by the contractor/subcontractor, and the name and phone number of a contact with the owning company or agency for which the work was completed;

(3) List of equipment that will be used for this project. The list shall include, as a minimum, equipment type, date of manufacture, and if contractor-owned or rented; and

(4) A list of all violations and citations in the past five years of applicable water and wastewater laws and statutes for both the prime contractor and the subcontractor responsible for the utility work.

The contractor shall submit this documentation to the Engineer for approval at least 21 calendar days prior to any anticipated work involving active sanitary sewer lines, whether new or existing.

(C) Protection of Existing Utility Lines:

At points where the contractor's operations are adjacent to right-of-way properties or easements for railway, telegraph, telephone, water, sewer, electric, gas, and cable television companies, hereinafter referred to as utilities, or are adjacent to other facilities and property, damage to which might result in considerable expense, loss, inconvenience, injury, or death, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The exact locations and depths of all utilities that are underground or the location of those on or near the surface of the ground which are not readily visible shall be determined. Such locations shall be marked in such a manner so that all workmen or equipment operators will be thoroughly apprised of their existence and location. It will be the contractor's responsibility to see that every effort possible has been made to acquaint those actually involved in working near utilities not only with the type, size, location and depth, but with the consequences that might follow any disturbance. No trenching or similar operation shall be commenced until the Engineer is satisfied that every possible effort has been taken by the contractor to protect utilities.

The contractor shall coordinate with others working near new or existing sewer lines or other utilities on the procedures to be followed to prevent damaging of these utilities.

(1) Sewage Discharge Prevention Plan (SDPP):

For any work which may impact active sanitary sewer pipes, whether new or existing, the contractor shall prepare a Sewage Discharge Prevention Plan (SDPP) which shall describe the contractor's procedures and work plan for such lines. The Sewage Discharge

Prevention Plan shall also describe the precautions that the contractor shall take to prevent unplanned breakage or spills, and the procedure which the contractor shall follow if breakage or a spill occurs.

The contractor's method of work described in the SDPP shall ensure that any work done in or near any active sewer line is performed in a safe and controlled manner resulting in no accidental discharges. As a minimum, the contractor's equipment and procedures shall be appropriate for the intended work, and shall conform to standard industry practices.

The SDPP shall include information, as specified below, for all portions of the project which involve the following work activities, and for any other element of work which may involve contact with an active sanitary sewer line:

(a) Interrupt, divert, relocate, plug, or abandon a sewer line or service connection; or

(b) Brace, or tie into a sewer line or service connection.

Construction activities in the vicinity of active sanitary sewer lines or service connections shall also be included in the SDPP if any of the following conditions exist:

(a) Any work crossing beneath the pipe, at any angle, regardless of vertical separation;

(b) Any work crossing over the pipe, at any angle, within 2 feet of the top of pipe; or

(c) Work located parallel to the pipe within the following areas:

(i) For the area from the bottom of the pipe to 2 feet above the top of the pipe, any work within 2 feet horizontally of the pipe wall; or

(ii) For the area below the bottom of the pipe, any work located below an imaginary line beginning at the pipe springline and progressing downward at a slope of 1.5 feet vertically to 1.0 feet horizontally.

The contractor’s Sewage Discharge Prevention Plan shall address each of the items tabulated below, as applicable, for every location where construction activity will involve an active sanitary sewer line.

(2) Required Elements of the Sewage Discharge Prevention Plan:

The following elements shall be addressed in the SDPP:

(a) Describe the proposed work in general, including the reasons for the work, scope, objectives, locations, dates, and estimated times the work will be conducted. Include project plan sheets detailing the proposed work, and indicating the peak flowrates of active sewer lines, determined as specified;

(b) For all existing sanitary sewer pipes, determine whether the lines are active or abandoned, and the peak flowrates of lines in service, as provided by the owner of the utility;

(c) List the key personnel (crew foreman, superintendent, and manager) and field office that are proposed to perform the work (include phone numbers);

(d) Describe the work in step-by-step detail for each location, including excavation plans and how both the new and existing structures and utilities will be identified and protected;

(e) Provide a detailed listing of any hardware, fittings, pipe plugs, flex couplings, tools, and materials needed to accomplish the work, and note the status of these items (on-hand, to-be-fabricated, on-order with expected delivery date, etc.). Include any manufacturer's specifications or recommendations, especially for any pipe plugs, sewer line fittings, and patching materials;

(f) List all major equipment to be used to perform the work. Include in this item any pumps that will be used to perform the work and the rated capacity of the pumps at the anticipated suction head;

(g) List all equipment to be used in the event of an unplanned release and specify how the equipment will be used. The locations of standby pumps shall be specified in this item. The plan shall indicate that all standby equipment to be used in the event of an unplanned discharge can be delivered to the site and put into service within two hours of identification of any unplanned flow;

(h) List the safety equipment to be used, and describe any unique safety procedures. Cite the applicable OSHA standards covering the work;

(i) Describe any contingency plans the contractor will implement in the event of unplanned releases and/or damage to existing facilities. List all personnel and subcontractors that will be responsible for responding to unplanned releases or damaged lines. Provide qualifications for all such personnel and subcontractors, including education, formal training, and relevant experience;

(j) Describe how the public will be protected during the work, and include or cite any applicable traffic control plans;

(k) Describe the quality control procedures that will be used in the field; and

(l) Discuss how temporary plugs or flow control devices will be secured, monitored, and removed.

The SDPP shall be in written form, and shall include any diagrams or sketches necessary for clarity. When possible, diagrams, and sketches should be shown using the applicable project plan sheets.

The contractor shall modify the SDPP as necessary throughout the project to include any new or revised information relevant to the items listed above. The contractor shall resubmit the revised SDPP to the Engineer for approval in each case.

(3) Sewage Discharge Prevention Plan Approval:

The SDPP shall be submitted to the Engineer at least 21 calendar days before any work involving an active sewer line is to be done. The Engineer will review the plan, solicit comments from the owner/operator of the sewer line, and return the plan to the contractor within 14 calendar days from original submittal.

No work involving active sanitary sewer lines shall be done until a final SDPP meeting all the requirements specified in Subsection 107.15(C)(2) of the specifications has been approved by the Engineer.

Approval of the contractor's Sewage Discharge Prevention Plans, personnel, or construction methods and operation shall not relieve the contractor from its responsibility to safely perform the work included in this contract, nor from its liability for damage resulting, either directly or indirectly, from its work performed under this contract.

(D) Service Connections:

(1) General:

In the event of interruption to water, sewer, or utility services as a result of accidental breakage or as a result of lines being exposed or unsupported, the contractor shall promptly notify the proper authority and shall cooperate with the said authority in the restoration of service. When service is interrupted, repair work shall be continuous until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

(2) Unidentified Water and Sewer Connections:

The contractor shall protect unidentified, undamaged water or sewer service connections encountered during excavation. The contractor shall immediately notify the Engineer when an unidentified service connection is encountered.

The contractor shall immediately repair unidentified water or sewer service connections that are damaged during excavation. Any damaged service connections shall be reported to the Engineer, including all remedial actions taken.

(E) Repairing Damaged Lines:

When the operations of the contractor result in damage to any utility line or service connection, the location of which has been brought to the contractor's attention, the contractor shall assume full responsibility for such damage.

Should an unplanned breakage occur in an active sewer line as a result of the contractor's operations, the contractor shall immediately notify the Engineer, and begin repairs to halt any flows and restore normal service, in accordance with the procedures described in the approved Sewage Discharge Prevention Plan. The contractor shall also immediately notify the affected utility company and the appropriate regulatory agencies. The contractor shall be responsible for repairing the damaged pipe, restoring any interruptions in service, and cleaning up the affected areas within 24 hours of the beginning of the spill. Sewage discharge damage assessments, as specified in Subsection 107.15(F) of the specifications, will be charged to the contractor for any unplanned breakage which results in a discharge.

The contractor shall be responsible to repair any breakage, in accordance with requirements of the broken line's owner/operator, and clean up the site per applicable codes and regulations of the EPA, OSHA, ADEQ, and all other agencies' specifications, at no additional cost to the Department.

(F) Sewage Discharge Damage Assessments:

The Department will assess sanctions in accordance with the Table 107.15-1 below for each 24-hour period, or portion thereof, for each

unplanned breakage that occurs in an active sanitary sewer line as a result of the contractor's operation. The rate of these sanctions is based on the type and quantity of effluent discharged as determined by the Engineer.

These sanctions do not relieve the contractor from any of its responsibilities under the contract, including any liquidated damages that may be assessed under Subsection 108.09 of the specifications for late completion of the project.

The sanctions specified in this subsection will be independent of any penalties imposed by others.

The contractor acknowledges that Regulatory agencies may assess or impose civil or criminal penalties on the contractor resulting from sewer discharges.

The Department will not be responsible for any civil or criminal penalties, fines, damages, or other charges imposed on the contractor by any regulatory agency or court for sewage discharges that are a result, directly or indirectly, of the contractor's work performed under this contract.

TABLE 107.15-1
SANCTIONS
(EACH 24-HOUR PERIOD, OR PORTION THEREOF)

Volume of Discharge	Raw Sewage or Industrial Wastewater	Treated Effluent
Less than 10,000 gallons	$5,000	$1,000
10,000 to 99,999 gallons	$10,000	$2,000
100,000 to 1 million gallons	$25,000	$3,000
Greater than 1 million gallons	$40,000	$5,000

These sanctions will be assessed for each 24-hour period, or portion thereof, until the contractor has completed all of the following tasks:

(1) Stopped the discharge;

(2) Repaired the damaged pipe;

(3) Restored normal service; and

(4) Fully cleaned and disinfected the site to the satisfaction of the Engineer.

Upon completion of tasks (1), (2), and (3) above, and prior to completion of Task (4), the sanctions for the current 24-hour period shall be at the rate shown in Table 107.15-1. However, for each subsequent 24-hour period, the assessment will be 1/2 of the rate shown in Table 107.15-1.

The sanctions will continue at the reduced rate until the site has been fully cleaned and disinfected to the satisfaction of the Engineer.

As an example, the amounts assessed each 24-hour period for an unplanned discharge of 20,000 gallons of raw sewage, in which the contractor completes tasks (1), (2), and (3) within the second 24-hour period but does not complete full cleanup until the third 24-hour period, will be as follows:

First 24-hour period:	$10,000
Second 24-hour period:	$10,000
Third 24-hour period:	$5,000

For this example, the total sanction will be $25,000 ($10,000 + $10,000 + $5,000).

107.16 Personal Liability of Public Officials:

In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Transportation Board and any member thereof, the Director, the Engineer, or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.17 No Waiver of Legal Rights:

Partial or final acceptance pursuant to Subsection 105.20 of the specifications shall not preclude or prohibit the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Department be precluded or prohibited from recovering from the contractor, or its surety, insurance or any combination thereof, such overpayment as it may sustain, or by failure on the part of the contractor to fulfill his obligations under the contract. A waiver on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards to the Department's rights under any warranty or guaranty.

107.18 Contractor and Subcontractor Records:

The contractor, subcontractors, and all suppliers shall keep and maintain all books, papers, records, files, accounts, reports, bid documents with backup data, including electronic data, and all other material relating to the contract and project for five years following completion and acceptance of the work.

All of the above material shall be made available to the Department for auditing, inspection and copying and shall be produced, upon request, at the Department offices located at 206 South 17th Ave., Phoenix, Arizona 85007.

The contractor shall insert the above requirement in each subcontract, purchase order and lease agreement and shall also include in all subcontracts a clause requiring subcontractors to include the above requirement in any lower-tier subcontract, purchase order or lease agreement.

107.19 Federal Immigration and Nationality Act:

(A) General:

The contractor, and all subcontractors, shall comply with all federal, state, and local immigration laws and regulations, as set forth in Arizona Executive Order 2005-30, relating to the immigration status of their employees who perform services on the contract during the duration of the contract. The State shall retain the right to perform random audits of contractor and subcontractor records or to inspect papers of any employee thereof to ensure compliance.

The contractor shall include the provisions of Subsection 107.19 of the specifications in all its subcontracts.

In addition, the contractor shall require that all subcontractors comply with the provisions of Subsection 107.19 of the specifications, monitor such subcontractor compliance, and assist the Department in any compliance verification regarding any subcontractor.

(B) Compliance Requirements for A.R.S. § 41-4401, Government Procurement, E-Verify Requirement; Sanctions:

By submission of a bid, the contractor warrants that the contractor and all proposed subcontractors are and shall remain in compliance with:

(1) All federal, state, and local immigration laws and regulations relating to the immigration status of their employees who perform services on the contract; and

(2) A.R.S. Section 23-214, Subsection A (That subsection reads: “After December 31, 2007, every employer, after hiring an employee, shall verify the employment

eligibility of the employee through the E-Verify program.").

A breach of a warranty regarding compliance with immigration laws and regulations shall be deemed a material breach of the contract, and the contractor and subcontractors are subject to sanctions specified in Subsection 107.19(D) of the specifications.

Failure to comply with a State audit process to verify the employment records of contractors and subcontractors shall be deemed a material breach of the contract, and the contractor and subcontractors are subject to sanctions specified in Subsection 107.19(D) of the specifications.

(C) Compliance Verification:

The State may, at any time and at its sole discretion, require evidence of compliance from the contractor or subcontractor.

Should the State request evidence of compliance, the contractor shall complete and return the State Contractor Employment Record Verification Form and Employee Verification Worksheet, provided by the Department, no later than 21 days from receipt of the request for such information.

Listing of the compliance verification procedure specified above does not preclude the Department from utilizing other means to determine compliance.

The State retains the legal right to inspect the papers of any employee who works on the contract to ensure that the contractor or subcontractor is complying with the warranty specified in Subsection 107.19(B) of the specifications.

(D) Sanctions for Non Compliance:

For purposes of this paragraph, non-compliance refers to either the contractor's or subcontractor's failure to follow immigration laws or to the contractor's failure to provide records when requested. Failure to comply with the immigration laws or to submit proof of compliance constitutes a material breach of contract. At a minimum, the Department will reduce the contractor's compensation by $10,000 for the initial instance of non-compliance by the contractor or a subcontractor. If the same contractor or subcontractor is in non-compliance within two years from the initial non-compliance, the contractor's compensation will be reduced by a minimum of $50,000 for each instance of non-compliance. The third instance by the same contractor or subcontractor within a two year period may result, in addition to the minimum $50,000 reduction in compensation, in removal of the offending contractor or subcontractor, suspension of work in whole or in part or, in the case of a third violation by the contractor, termination of the contract for default.

In addition, if a contractor is in non-compliance three times within a two-year period, the Department will revoke the contractor's prequalification for a minimum of one year. Subcontractors and suppliers who are in non-compliance three times within a two-year period will be prohibited from participating in Department contracts for a minimum of one year.

Subcontractors who are in non-compliance three times within a two-year period, and who are prequalified with the Department as prime contractors, will also have such prequalifications revoked for a minimum of one year.

After the minimum one-year suspension, contractors, subcontractors, and suppliers may be considered eligible to participate in Department contracts, but only after successful demonstration, to the satisfaction of the Department, that their hiring practices comply with the requirements specified herein. If considered eligible, contractors shall be required to re-apply for prequalification and be accepted prior to bidding on Department contracts. Subcontractors interested in bidding on Department contracts as prime contractors shall also be required to re-apply for prequalification and be accepted prior to bidding. For purposes of considering suspension: (1) non-compliance by a subcontractor does not count as a violation by the contractor, and (2) the Department will count instances of non-compliance on other Department contracts.

The sanctions described herein are the minimum sanctions; in case of major violations the Department reserves the right to impose any sanctions up to and including termination, revocation of prequalification, and prohibition from participation in Department contracts, regardless of the number of instances of non-compliance.

Contractors, subcontractors, and suppliers may appeal the sanctions to the State Engineer. That appeal must be in writing and personally delivered or sent by certified mail, return receipt requested, to the State Engineer. The appeal must be received by the State Engineer no later than seven calendar days after the Department's determination. The State Engineer shall promptly consider any appeals and notify the interested party of the State Engineer's findings and decision. The State Engineer's decision shall be considered administratively final.

Any delay resulting from a compliance verification or a sanction under this subsection is a non-excusable delay. The contractor is not entitled to any compensation or extension of time for any delays or additional costs resulting from a compliance verification or a sanction under this Subsection 107.19 of the specifications.

An example of the minimum sanctions under this subsection is presented in the following table:

Offense by:			Reduction in Compensation
Contractor	Subcontractor A	Subcontractor B	
First			$10,000
	First		$10,000
	Second		$50,000
		First	$10,000
	Third		$50,000*

Note:

* Will, in addition, result in removal of the subcontractor, prohibition from participating in Department contracts, and revocation of any Department prequalifications that the subcontractor may have obtained.

SECTION 108 PROSECUTION AND PROGRESS:

108.01 Subletting of Contract:

The contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof or of the contractor's right, title or interest therein without written consent of the Engineer. In case such consent is given, the contractor will be permitted to sublet a portion thereof, but shall perform with the contractor's own organization work amounting to not less than 40 percent of the original contract amount. No subcontracts or transfer of contract shall release the contractor of its liability under the contract and bond.

"Contractor's own organization" shall be construed to include only workers employed and paid directly by the prime contractor and equipment owned or rented by it, with or without operators. Such term does not include employees or equipment of a subcontractor, assignee, or agent of the prime contractor.

The contract amount upon which the 40-percent requirement is computed includes the cost of materials and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

A person who has been convicted of a violation of A.R.S. Section 34-252 is not eligible to enter into any contract either as a contractor, subcontractor, or supplier, for a period of up to three years, from date of conviction, as determined by the court. A person means any individual, partnership, corporation, association, or other entity formed for the purpose of doing business as contractor, subcontractor, or supplier.

The Department may also refuse to approve any entity as a subcontractor or supplier for any of the reasons for which it could refuse

to allow an entity to submit a bid, suspend the entity from bidding, or declare the entity non-responsible.

The Department's consent to a subcontract will be given only after the Department determines that the subcontract, purchase order, or lease agreement is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract. The following data shall be submitted seven calendar days prior to the start of each subcontractor's work, except data regarding DBE subcontracts must be submitted at the preconstruction conference:

(A) A complete copy of each subcontractor agreement and each second tier subcontractor.

(B) Verification that all required Federal Provisions; i.e., Federal Form 1273, Executive Order, and Wage Determination Decisions are attached to each subcontract in any federal-aid funded contract.

(C) Subcontracts must show the total price subcontracted. The items of work, and quantities of each item subcontracted shall be shown. Unit Prices or Extended Prices may be deleted except in the case of DBE subcontractors.

(D) DBE subcontracts shall include full extensions of all unit prices.

(E) Partial items shall be explained in detail and show the amount of each contract item being subcontracted. Non-contract item work shall be fully explained, i.e., Trucking 1,000 hours, Truck Asphaltic Concrete.

(F) The contractor shall certify to the Department that all of its subcontractors have all required registrations.

(G) An alternative dispute resolution process to resolve payment and prompt payment disputes shall be included in each subcontract.

The Engineer will not consent to subletting of any portion of the contract until the Engineer receives a copy of the subcontract that has been approved by the Department, lower tier subcontract, or Subcontractor Request Form (SRF).

When a contractor submits a SRF, a complete executed subcontractor agreement should be attached to the form. If the contractor does not attach the subcontract, the subcontract must be submitted to the Department within 30 days of the approval date of the original approved SRF.

If the subcontract agreement does not contain the pertinent provisions and requirements as indicated by the original approved SRF or, if the contractor fails to submit the subcontract within 30 days of the approval date of SRF, the Engineer will revoke the consent to sublet.

The Engineer will not consent to subletting of any portion of the contract until the AZUTRACS Registration Number for the subcontractor has been provided.

The contractor's schedule shall allow three calendar days, excluding weekends and holidays, for the Department's subcontract review of each SRF.

The Engineer's consent shall in no way be construed to be an endorsement of the subcontractor or its ability to complete the work in a satisfactory manner.

If a subcontractor, of any tier, begins work on the contract prior to the contractor submitting the required documentation and receiving consent from the Engineer, the Department will retain $1,000 from monies due or becoming due the contractor. The money retained will be for each subcontractor, of any tier, that starts work without the consent of the Engineer. These sanctions will be in addition to all other retention or liquidated damages provided for elsewhere in the contract.

If a subcontractor, of any tier, is found working on the project without an approved contract the Engineer will immediately stop work on the subcontract. Work shall not resume until all required documentation is submitted and approved by the Engineer. The contractor shall not be entitled to additional compensation or an extension of contract time for any delays to the work because of the contractor's failure to submit the required documentation.

Calculation of the 60 percent subcontracting limit will be based upon the amount of work subcontracted and verified by subcontract documents.

Subcontractors performing contracting work subject to A.R.S. Sections 32-1101 et seq. shall be duly licensed in accordance with those statutes. Subcontractors providing other services shall be licensed in accordance with the requirements of Arizona Law.

108.02 Start of Work:

Work shall not be started until the contract has been executed by both the contractor and the Department.

The contractor shall begin work within the number of calendar days after the date of notice of award of contract as follows:

Contract Size (Dollars)	Calendar Day Period
0 to 10,000,000	30
over 10,000,000 to 30,000,000	45
over 30,000,000	60

When the contract time is on a calendar day basis or on a working day basis, contract time will be charged commencing on the date 30, 45, or 60 calendar days, as determined by the contract size, after the date of the notice of award letter. Should this date fall on a Saturday, Sunday or holiday, the next working day shall be considered the starting date for the purpose of charging contract time.

108.03 Preconstruction Conference:

The contractor shall meet with the Engineer for a preconstruction conference prior to commencing work. The conference may be combined with the partnering conference, and all requirements of this subsection may be submitted at that time. Should both conferences be held at the same time, the partnering conference will be held first.

At the preconstruction conference the contractor shall submit a progress schedule showing the order in which the contractor proposes to carry out the work, the dates on which the contractor and its subcontractors will start the work, including procurement of materials, equipment, etc.; the ordering of articles of special manufacture; the furnishing of drawings, plans and other data required under Subsection 105.03 of the specifications for the review and approval of the Engineer; the inspection of structural steel fabrication; and the contemplated dates for the completion. The schedule shall be in a critical path method format. No schedule activity shall be shorter than one day or longer than 20 days. The schedule must show interrelationships among the activities, and the controlling items of work throughout the project shall be identified. If requested by the Engineer, the contractor shall furnish information needed to justify activity time durations. Such information shall include estimated manpower, equipment, unit quantities, and production rates. The schedule shall illustrate the completion of the work not later than the contract completion date.

The contractor shall notify the Engineer in writing of proposed major changes in the progress schedule. Major changes are those that may affect compliance with the contract requirements or that change the critical path or controlling item of work.

The contractor shall furnish authorized signature forms and a list of the contractor's proposed subcontractors and major material suppliers.

Progress schedules shall have considered the time requirement for ordering articles of special manufacture to meet specific requirements

of the work and Subsection 604-3.04 of the specifications when structural steel fabrication inspection is required.

If the contract has a DBE requirement, the contractor shall submit copies of completed and signed DBE subcontracts, purchase orders, or invoices to the Department.

The contractor shall submit a traffic control plan in accordance with Subsection 701-1 of the specifications. The contractor shall designate an employee who is competent and experienced in traffic control to implement and monitor the traffic control plan. The qualifications of the designated employee must be satisfactory to the Engineer. Such designated employee shall have successfully completed a recognized traffic control supervisor training program. The traffic control supervisor training provided by the American Traffic Safety Services Association (ATSSA) or the IMSA shall be acceptable. Training through other programs must be approved in advance by the Engineer. The contractor shall submit proof that the proposed individual has completed an approved training program at the preconstruction conference. The training shall be current, and must be valid throughout the duration of the project. In order to remain current with the Department, the traffic control supervisor training shall be completed or renewed every four years.

The contractor shall submit a safety plan and designate an employee as Safety Supervisor, in accordance with Subsection 107.08 of the specifications.

The traffic control plan and safety plan shall be satisfactory to the Engineer.

During the preconstruction conference, the Engineer will designate a Department employee or employees who will be responsible to see that the traffic control plans and any alterations thereto are implemented and monitored to the end that traffic is carried through the work in an effective manner. If approved by the Engineer, the contractor may designate one employee to be responsible for both the traffic control and safety plans. The contractor shall not designate its superintendent as the responsible person for either the traffic control plan or the safety plan, unless approved by the Engineer.

If the project requires that contractor or State personnel to work from falsework, within shoring, or in any other hazardous area the contractor shall submit as part of the contractor's safety plan specific measures it will use to ensure worker safety.

The contractor shall also submit a program for erosion control and pollution prevention, as set forth in Subsection 104.09 of the specifications, on all projects involving clearing and grubbing, earthwork, structural work, or other construction, when such work is likely to create erosion or pollution problems.

If the contractor fails to provide the required submissions, the Engineer may order the preconstruction conference suspended until such time as they are furnished. Work shall not begin until the preconstruction conference has been concluded and the safety plan has been approved, unless authorized by the Engineer. The contractor shall not be entitled to additional compensation or an extension of contract time resulting from any delays due to such a suspension.

When the specifications require specific quality control measures for certain materials by referencing Subsection 106.04(C) of the specifications, the contractor shall designate a qualified employee as Quality Control Manager. The Quality Control Manager shall be responsible for the implementing and monitoring of the quality control requirements described in Subsection 106.04(C) of the specifications.

108.04 Prosecution and Progress:

The contractor shall start the work in accordance with the requirements of Subsection 108.02 of the specifications. The contractor shall notify the Engineer at least seven working days prior to beginning work.

The contractor shall submit its Asphaltic Concrete Mix Design, in accordance with the applicable subsections of Sections 409, 415, 416, and 417 of the specifications, at the preconstruction conference, unless otherwise approved in writing by the Engineer.

Unless suspended, the work shall be diligently and continuously carried on to completion and the contractor agrees to provide at all times an adequate force of labor and sufficient materials and equipment to insure the completion of the contract within the time allowed. The progress of the work shall be at a rate sufficient to complete the contract in an acceptable manner within the time allowed.

At a mutually convenient location and time, the contractor shall meet weekly with the Engineer to discuss construction activities; however, a meeting may be waived if mutually agreed to, due to weather conditions, work progress, or for other reasons. At the meetings, the contractor shall provide the Engineer with a detailed, written schedule of construction activities and phases of work for the current week, forthcoming three-week period as well as the construction activities which were performed during the previous week. This schedule shall detail the anticipated start dates and anticipated completion dates of work activities. The weekly schedule should reflect, at a minimum, all activities from the most recently updated project schedule. For work which was completed during the previous week, this schedule shall detail the actual start and completion dates of work activities as well as indicate the status of major ongoing activities. Upon the second occurrence of the contractor failing to provide an accurate schedule as described herein and after written notification by the Engineer of the first occurrence, the Department will deduct $500 from the contractor's progress payment per each occurrence thereafter. Minutes of the weekly

meetings will be kept by the Engineer and a copy given to the contractor for review and acceptance.

Schedule changes requiring an increase in the Department's engineering personnel will not be put into effect for 10 days after the submission of weekly schedules detailing such activities, or until the Engineer has made arrangements for additional personnel, whichever is the shorter time.

Every 30 days throughout the contract, or at any other time as requested by the Engineer, the contractor shall submit a revised progress schedule reflecting the actual progress of activities, all activity logic revisions, the anticipated completion dates of the major phases of work remaining, and the anticipated completion date of the work.

108.05 Limitation of Operations:

The contractor shall conduct the work at all times in such a manner and in such sequence as will ensure the least interference with traffic and the safety of the public and the protection of the workmen. It shall have due regard to the location of detours and to the provisions for handling traffic. It shall not open up work to the prejudice or detriment of work already started. The Engineer may require the contractor to finish a section of work which is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

Except as required to protect work already accomplished, to provide dust control and for work of a similar nature, no work on Sundays or holidays will be permitted unless written permission is obtained from the Engineer. The contractor shall advise the Engineer at least 24 hours in advance if the contractor elects to work on any Saturday, Sunday, or holiday.

In general, all work shall be performed during daylight hours. If the contractor elects to perform work at night or if the contractor is required to do so in the Special Provisions, the contractor shall furnish, erect, and maintain an amount of artificial lighting sufficient for the construction, flagging, inspection, etc. and for the safety of the workers and the traveling public. No night work shall be performed until the Engineer is satisfied that an adequate amount of artificial light has been furnished and placed properly.

108.06 Character of Workers:

The contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to fulfill completion in the manner and within the time required by these specifications.

All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled

work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any person employed by the contractor or by any subcontractor who, in the opinion of the Engineer, does not perform the contractor's work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed immediately by the contractor or subcontractor employing such person and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the contractor fail to remove such person or persons as required above or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until compliance.

108.07 Methods and Equipment:

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet the requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no damage to the roadway, adjacent property, or other highways will result from its use.

When the construction methods and types of equipment to be used by the contractor in accomplishing the construction are not set forth in the contract, the contractor may use any methods or equipment that it demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the contractor desires to use a method or type of equipment other than those specified in the contract, it may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the method and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the contractor shall be fully responsible for producing construction work in conformity with the contract requirements. If after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The contractor shall either remove the deficient work or replace it with work of specified quality or take such other corrective action as the Engineer may direct.

108.08 Determination and Extension of Contract Time:

The Contract Time, as defined in Section 101 of the specifications, will be stated in the Special Provisions.

When the contract time is on a working day basis, the Engineer will furnish the contractor a weekly statement showing the number of days charged to the contract for the preceding week and the number of days specified for completion of the contract. The contractor will be allowed one week after the contractor has received the statement in which to file a written protest with the Engineer setting forth in what respect such weekly statement is incorrect; otherwise the statement shall be deemed to have been accepted by the contractor as correct.

When the contract time is on a calendar day basis, it shall consist of the number of calendar days stated in the contract counting from the starting date and including all Sundays, holidays and non-work days. All calendar days elapsing between the effective dates of any orders of the Engineer to suspend work and to resume work for suspensions not the fault of the contractor will be excluded.

When the contract completion time is a fixed calendar date, this date shall be the date on which all work on the project is required to be substantially complete.

Contract time is based on the amount of work included in the original contract. If satisfactory fulfillment of the contract involves alterations to the contract that affect the contractor's completion time, the contractor may request a supplemental agreement which extends the contract time. Such request will be made in accordance with Subsection 104.03 of the specifications, shall be in the form of a Request for Extension of Contract Time, and shall include the contractor's revised schedule and all other pertinent data. The request shall show why an increase of contract time is warranted.

An extension of contract time will not be considered unless the work affected is a controlling item on the contractor's schedule at the time of the alteration or becomes a controlling item as a result of the alteration.

If a nationwide shortage exists in basic materials or standard items which are necessary in the fabrication or manufacture of equipment, parts or articles to meet the specific requirements of the project, a serious widespread shortage of such equipment, parts or articles may be considered as a valid reason for the extension of contract time. Delivery delays or shortages caused by ordinary supply fluctuations are not nationwide shortages and therefore are not valid reasons for extension of time.

The contractor's plea that insufficient time was specified is not a valid reason for extension of time.

If the contractor requests additional time and if the Engineer finds that the work activities controlling overall job progress and the projected

completion date were delayed because of conditions beyond the control and without the fault of the contractor, and could not have been anticipated by the contractor, the Engineer may extend the time for completion in such amount as the conditions justify. The extended time for completion shall then be in full force and effect the same as though it were the original time for completion.

When substantial completion has been duly determined by the Engineer in accordance with the requirements of Subsection 105.19 of the specifications, the daily charge of the contract will cease.

108.09 Failure to Complete the Work on Time:

For each calendar day or working day, as specified, that the contractor shall fail to achieve substantial completion after the contract time or calendar date specified for the completion of the work provided for in the contract, the sum shown in the schedule of liquidated damages specified below will be deducted from any monies due the contractor, not as a penalty, but as liquidated damages; provided, however, that due account will be taken of any adjustment of the contract time for the completion of the work allowed under the provisions of Subsection 108.08 of the specifications.

Permitting the contractor to continue and finish the work or any part of it after the contract time has expired or after the date to which the time for completion may have been extended will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

When the contract time contains construction phase(s) and landscape establishment phase, the construction phase(s) will be considered for the requirements specified above. The construction phase shall be defined as all work not included in landscape establishment phase. The landscape establishment phase shall be as described and specified under Section 807 of the specifications.

SCHEDULE OF LIQUIDATED DAMAGES			
Original Contract Amount		Liquidated Damages Per Day	
From More Than:	To and Including:	Calendar Day or Fixed Date:	Working Day:
$ 0	$ 500,000	$ 300	$ 1,000
$ 500,000	$ 1,000,000	$ 850	$ 1,700
$ 1,000,000	$ 2,000,000	$1,250	$ 2,650
$ 2,000,000	$ 5,000,000	$ 2,100	$ 3,800
$ 5,000,000	$ 10,000,000	$ 3,300	$ 6,850

SCHEDULE OF LIQUIDATED DAMAGES			
$ 10,000,000	$ 30,000,000	$ 7,300	$ 10,550
$ 30,000,000	$ 60,000,000	$ 9,350	$ 17,750
$ 60,000,000	$ 90,000,000	$ 19,900	$ 27,850
$ 90,000,000	-------	$ 27,450	$ 38,400

108.10 Termination of Contract for Default:

If the contractor:

(A) Fails to begin the work under the contract within the time specified, or

(B) Fails to perform the work with sufficient workers and equipment or with sufficient materials to ensure the prompt completion of said work, or

(C) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or

(D) Discontinues the prosecution of the work, or

(E) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

(F) Becomes insolvent, or

(G) Allows any final judgment to stand against it unsatisfied for a period of 10 days, or

(H) Makes an "assignment for the benefit of creditors,", or

(I) Fails to comply with contract requirements regarding minimum wage payments or equal employment opportunity requirements, or

(J) Is a party to fraud, or

(K) For any other cause whatsoever, fails to carry on the work in an acceptable manner,

The Engineer will give notice in writing to the contractor and to the contractor's surety of such delay, neglect or default.

If the contractor or the contractor's surety within a period of 10 days after such notice shall not proceed in accordance therewith, the Department will, upon written notification from the Engineer of the fact of such delay, neglect or default and the contractor's failure to comply with such notice, have full power and authority without violating the contract to terminate the contract. The Department may appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof or use such other methods as in the opinion of the Engineer will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due said contractor. If such expense exceeds the sum which would have been payable under the contract, then the contractor and the contractor's surety shall be liable and shall pay to the Department the amount of such excess.

If it is determined, after termination of the contractor's right to proceed, that the contractor was not in default, the rights and obligations of the parties will be the same as if the termination had been issued for the convenience of the Department in accordance with Subsection 108.11 of the specifications. Thus, damages to which the contractor and the surety may be entitled as a result of an improper default termination will be limited to the amounts provided for in Subsection 108.11 of the specifications.

108.11 Termination of Contract for Convenience of the Department:

The Department may terminate the entire contract or any portion thereof, if the Engineer determines that a termination is in the Department's best interest. The Engineer will deliver to the contractor a Written Order of Termination specifying the extent of termination and the effective date.

(A) Submittals and Procedures:

After receipt of a Written Order of Termination the contractor shall immediately proceed with the following obligations:

(1) Stop work as specified in the notice.

(2) Place no further subcontracts for orders or materials, services, equipment or facilities, except as necessary to complete the continued portion of the contract.

(3) Terminate all subcontracts or orders for materials, services, equipment or facilities to the extent they relate to the work terminated.

(4) Transfer title and deliver to the Department:

(a) The fabricated, partially fabricated, or unfabricated parts; work in process; completed work; supplies; and other material produced or acquired for the work terminated.

(b) The completed or partially completed plans, drawings, information, and other property that, if the contract had been completed, would be required to be furnished to the Department.

(5) Take any action necessary, or that the Engineer may direct, for the protection and preservation of the property related to the contract that is in the possession of the contractor and in which the Department has or may acquire an interest.

(6) Complete performance of the work not terminated.

(B) Inventory:

Acceptable materials obtained by the contractor for the project that have not been incorporated in the work shall be inventoried in conjunction with the Engineer at a date identified by the Engineer.

(C) Settlement Provisions:

When the Department orders termination of all or a part of the contract effective on a certain date, completed items of work as of that date will be paid for at the contract bid price. Payment for partially completed work or for items that are eliminated in their entirety will be made either at agreed prices or under the provisions below.

(1) Additional Costs:

Within 60 calendar days of the effective termination date the contractor shall submit a claim to the Engineer for additional damages or costs not covered above or elsewhere in the contract. Such claim may include such cost items as reasonable idle equipment time, mobilization efforts, bidding and project investigative costs, overhead expenses attributable to the project terminated, legal and accounting charges involved in claim preparation, subcontractor costs not otherwise paid for, actual idle labor cost if work is stopped in advance of termination date, guaranteed payments for private land usage as part of the original contract, and any other cost or damage for which the contractor feels reimbursement should be made. Anticipated profits will not be considered as part of any settlement.

The contractor and the Department may agree upon the whole or any part of the amount to be paid because of the termination. The amount

may include a reasonable allowance for profit on work done. The agreed amount may not exceed the total contract price as reduced by the amount of payments previously made, and the contract price of work not terminated. The contract shall be amended, and the contractor paid the agreed amount.

(2) Additional Cost Review:

If the contractor and the Department fail to agree on the whole amount to be paid to the contractor because of the termination of work, the Department will pay the amounts determined as follows, but without duplication of any amounts agreed upon above:

(a) For contract work performed before the effective date of termination, the actual and reasonable costs of work performed and inventoried materials, plus a reasonable profit thereon, not to exceed unit bid prices.

(b) The reasonable costs of settlement of the work terminated, including:

(i) Accounting, legal, clerical, and other expenses reasonably necessary for the preparation of termination settlement Proposals and support data;

(ii) The termination and settlement of subcontracts and orders for materials, services, equipment and facilities; and

(iii) Storage, transportation, and other costs incurred, as reasonably necessary for the preservation, protection, or disposition of the termination inventory.

(c) Except for normal spoilage, and to the extent that the Department expressly accepts the risk of loss, Department will exclude from the fair value, all that is destroyed, lost, stolen, or damaged so as to become undeliverable to the Department or to the buyer.

(d) In arriving at the amount due the contractor under this clause, the Department will deduct:

(i) All unliquidated advance or other payments to the contractor under the terminated portion of the contract;

(ii) Any claim that the Department has against the contractor under the contract; and

(iii) The agreed price for, or the proceeds from the sale of materials, supplies, or other things acquired and sold by the contractor not recovered by or credited to the Department.

If the termination is partial, the contractor may file a Proposal with the Department for an equitable adjustment of the price(s) of the continued portion of the contract. The Department will make any equitable adjustment agreed upon. Any proposal for an equitable adjustment under this clause shall be requested within 90 calendar days from the effective date of termination unless extended in writing by the Engineer.

The Department may, under the terms and conditions it prescribes, make partial payments and payments against costs incurred by the contractor for the terminated portion of the contract, if these payments will not exceed the amount to which the contractor is entitled.

The contractor shall maintain and make available all project cost records to the Department for audit to the extent necessary to determine the validity and amount of each item claimed. This includes all books and other evidence bearing on the contractor's costs and expenses under the contract. These records and documents shall be made available to the Department at the contractor's office, at all reasonable times, without any direct charge. If approved by the Department, photographs, microphotographs, or other authentic reproductions may be maintained instead of original records and documents.

Termination of the contract or portion thereof shall not relieve the contractor of contractual responsibilities for the work completed, nor shall it relieve the Surety of its obligation for and concerning any just claim arising out of the work performed.

SECTION 109 MEASUREMENT AND PAYMENT:

109.01 Measurement of Quantities:

All work completed under the contract will be measured by the Engineer according to United States standard measures.

A station when used as a definition or term of measurement will be 100 linear feet.

The methods of measurement and computation to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

All items which are to be measured on an area basis will, unless otherwise specified, be measured by longitudinal and transverse measurements made along the surface area in such manner as to ascertain reasonably the true area of the item actually placed in accordance with contract requirements. No deductions will be made for individual fixtures having an area of 9 square feet or less.

Structures will be measured according to neat lines shown on the project plans or as altered to fit field conditions.

Unless otherwise specified, all items which are to be measured by the linear foot will be measured along or parallel to the longitudinal axis of that item in such manner as to ascertain reasonably the true length of the item.

In computing volumes of earthwork the average end area method or other acceptable methods will be used. Corrections will not be made for curvature, prismoidal corrections and similar refinements unless specified.

The nominal diameter of wire, and the thickness of plates and sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fractions of inches.

The wire size in welded wire fabric used for concrete reinforcement will be identified by a W number directly corresponding to the cross-sectional area of the wire in hundredths of a square inch.

The term "ton" will mean the short ton consisting of 2,000 pounds avoirdupois. All materials which are measured or proportioned by weight shall be weighed on accurate approved scales.

Where the specifications require scales for the determination of weight, the use of load cells and electronic digital readout will be acceptable for all applications. The weighing system shall conform to and be maintained in accordance with the requirements of the Department of Weights and Measures.

When using platform scales, materials shall be weighed by or under the inspection of Department personnel. When using hopper scales, Department personnel may weigh or inspect materials to be measured for payment. Inspection of weigh operations may be performed by the Engineer at any time.

Scales of acceptable size shall be furnished by the contractor and shall be sealed by an inspector of the Department of Weights and Measures, State of Arizona, or a Licensed Service Agency approved by the State of Arizona Department of Weights and Measures. The Licensed Service Agency certifying the scales shall not be affiliated with the contractor or company supplying the materials for payment by weight.

During weighing operations, weights will be read and recorded to the nearest 100 pounds. The gross, tare, and net weights of each load will be recorded and documented with all or part of the following information as applicable to the type of scales and recording system used:

Project Identification
Contract Item Number
Material Source/Plant Identification
Date
Load Number
Truck Identification
Time of Weighing
Applicable Weights
Weighperson's Signature

Scales shall be resealed as often as required to assure accurate weights; scales shall be resealed at least once every 365 calendar days. The contractor shall also provide with each scale at least twenty 50-pound certified weights to be used in checking the scale. Each weight shall be recertified one year from the date of previous certification by the Department of Weights and Measures Metrology Laboratory. Each weight shall be stamped with a number, and the contractor shall furnish a certificate showing the numbers of the weights and the dates of certification. Certification will be obtained from the Department of Weights and Measures Metrology Laboratory.

Tests conducted by the Engineer to check the accuracy of scales shall not relieve the contractor of the responsibility of maintaining the accuracy of the scales.

No measurement or direct payment will be made for all of the measures hereinbefore described taken to seal scales, provide and certify weights and to weigh materials.

Each platform scale installation shall be provided with a shelter for the scale operator. The shelter shall be weatherproof and shall be provided with adequate ventilation, light, a stool, and a work bench.

The contractor shall provide means for heating or cooling the shelter to a reasonably comfortable degree if the work is in progress during cold or hot weather. The approximate minimum dimensions for the shelter shall be 6 feet in width, 8 feet in length and 7 feet in height.

When material will be measured by weight for payment using platform scales, trucks hauling such material shall be weighed empty at least once daily and at such other times as the Engineer directs. Each truck shall bear a plainly legible identification mark.

Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable

to the Engineer, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their water level capacity.

When requested by the contractor and approved by the Engineer in writing, material specified to be measured by the cubic yard may be weighed and such weight will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the contractor before such method of measurement of pay quantities is used.

Bituminous materials will be measured either by the gallon or by the ton.

When bituminous materials are measured by the gallon, the volume as measured shall be corrected to the volume at 60 degrees F. Conversion from volume at 60 degrees F to tons is made in accordance with the requirements of Table 1005-6.

Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when bituminous material has been lost from the car or the distributor, wasted or otherwise not incorporated into the work.

When bituminous materials are shipped by truck or rail, net certified weights or volume subject to correction for loss or foaming, may be used for computing quantities.

Cement will be measured by the ton or the hundredweight.

Timber will be measured by the 1,000 feet board measure, M.F.B.M., actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

The term "lump sum" when used as an item of payment will mean complete payment for the work described in the proposal.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

109.02 Scope of Payment:

The contractor shall accept the compensation provided in the contract as full payment for furnishing all labor, materials, tools, equipment, and incidentals necessary to the completed work and for performing all work contemplated and embraced under the contract; also for loss or damage arising from the nature of the work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the work until the acceptance by the Department and for all risks of every description connected with the prosecution of the work; also for all expenses incurred in consequence of the suspension or discontinuance of the work as provided in the contract; and for completing the work according to the plans and specifications. Neither the payment of any estimate nor of any retained percentage shall relieve the contractor of any obligation to make good any defective work or material.

No compensation will be made in any case for loss of anticipated profits.

If the "Basis of Payment" clause in the specifications relating to any unit price in the bidding schedule requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item which may appear elsewhere in the specifications.

109.03 Compensation for Altered Quantities:

When the accepted quantities of work vary from the quantities in the bid schedule, the contractor shall accept as payment in full, payment at the original contract unit prices for the accepted quantities of work. No adjustments in the contract unit prices will be allowed, except as provided by Subsection 104.02 of the specifications. Under no circumstances will a modification of contract unit prices be made for loss of expected reimbursement or loss of anticipated profits suffered or claimed by the contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement or from any other cause.

109.04 Adjustments in the Contract Price:

Adjustments in the contract price may be made only by Supplemental Agreement. The contract price adjustments set forth in a Supplemental Agreement must be determined in accordance with this subsection. Efforts to establish the calculation of the contract price adjustment must be accomplished in the order set forth in this subsection.

(A) Letter Agreement for Alterations of $10,000 or Less:

When the Department makes alterations in the details of construction or specifications that are limited in scope to the extent that the cost of the alterations will not exceed $10,000, the Engineer and the contractor may reach agreement upon the scope of work and a lump sum amount to cover the cost of the work to be performed. This agreement shall be reflected in a letter from the Engineer to the contractor, which, when executed by both parties, shall have the same force and effect as a supplemental agreement. Work shall not proceed until both parties have signed the agreement. This work will be paid for under ITEM 9240101 - Miscellaneous Work, at the lump sum amount agreed upon, which item will not be a part of the Bidding Schedule, but will be established by the Engineer through the initial letter agreement.

(B) Unit Prices:

Should paragraph (A) above not apply, an attempt must be made, before proceeding to any other pricing method, to price the work described by the Supplemental Agreement in accordance with the unit prices provided for each bid item.

(C) Detailed Estimate:

If agreement cannot be reached by the Engineer and contractor to price the Supplemental Agreement in accordance with the unit prices provided for bid items, then the contractor must provide a detailed estimate of its proposed unit prices or lump sum amount to perform the work described in the Supplemental Agreement. This detailed estimate must include the following:

(1) Estimate of labor effort by trade in man hours for each task.

(2) Estimate of base labor and burdened labor rate.

(3) Estimate of equipment cost including time requirements and rate.

(4) Estimated cost of materials.

(5) Estimated cost to be expended by subcontractors, prepared to the same level of detail as required in items (1) through (4) above.

(6) Any other costs to which the contractor feels it is entitled. Each such cost shall be presented in detail similar to items (1) through (5) above.

(7) Mark-up percentage, if used, for overhead, profit, or bond. The maximum allowable markup for the prime contractor shall be 15 percent for work performed by the prime contractor and 5 percent for work performed by subcontractors. The maximum allowable markup for the subcontractor is 15 percent, but in no event will the cumulative amount paid to the prime contractor and subcontractors for overhead, profit or other markups for any work exceed 20 percent of the estimate set forth in (1) through (4) above.

The contract price adjustment shall be based on the actual cost to the contractor as determined in (C)(1) through (C)(7) above, rather than on a force account basis, whenever possible.

The contractor will be allowed 10 calendar days to prepare such a cost estimate. Direction to proceed with the work described in the Supplemental Agreement will not be provided to the contractor by the Engineer until a detailed estimate is provided. The contractor will not be entitled to an adjustment in the contract price or time for the time required to prepare and submit a detailed cost estimate.

Upon receipt of the contractor's estimate, the Engineer will immediately schedule negotiations. Should such negotiations be conducted and a contract price adjustment not be agreed upon, the Engineer will consider the performance of the work on a force account basis, although the Engineer may at any time direct the contractor to proceed with the work on a force account basis.

(D) Force Account:

If directed by the Engineer, work required by Supplemental Agreement may be performed on a force account basis. Such work will be compensated in the following manner:

(1) Labor:

For all labor, including foreman in direct charge of specific operations, but excluding general superintendence, the contractor will be paid:

(a) Regular pay (RP) which will be determined as follows:

$$RP = (WR + FR) \times 1.5$$

Where: WR= Hourly wage rate as determined by payroll

FR= Fringe benefit rate as determined by payroll

The contractor shall provide the hourly wage rates and fringe benefit rate at the preconstruction conference. The rates will be verified by comparison to the contractor's payrolls.

(b) Overtime pay (OT) which will be determined as follows:

$$OT = [(WR \times 1.5) + FR] \times 1.5$$

(c) Subsistence and travel allowances paid to workers as required by collective bargaining agreements, or as approved by ADOT Construction Group. Rates for lodging, meals, and mileage shall not exceed the rates published by the State at the time of the force account work. No markup will be allowed for profit or overhead.

(2) Materials:

For all materials accepted by the Engineer and used in the work, the contractor will be paid the actual invoice cost of such materials including actual freight and express charges less all offered or available discounts and rebates, not withstanding the fact that they may not have been taken by the contractor. To the above cost will be added a sum equal to 15 percent thereof.

The Department reserves the right to furnish such materials as it deems appropriate, and the contractor shall have no claims for any costs, overhead, or profit on materials provided by the Department.

No partial payment will be allowed. The contractor shall be compensated for materials after the materials invoice is submitted along with any documentary backup for the cost of materials.

(3) Equipment:

Equipment which the Engineer considers necessary for the performance of work will be eligible for payment at the established rates only during the hours that it is operated except as otherwise allowed elsewhere in these specifications. Equipment hours will be recorded to the nearest one-half hour. For the use of equipment owned by the contractor and approved by the Engineer, the contractor will be paid the rental rates, as modified herein, outlined in the Rental Rate Blue Book® (RRBB) for Construction Equipment which is updated by EquipmentWatch™, a division of Fusable, 3200 Rice Mine Road NE, Tuscaloosa, Alabama 35406, phone (888) 307-1713. All rate determinations will be based on the RRBB quarterly rate revisions that are applicable at the time the equipment is being used.

(a) **Rental Rates (Without Operators):**

The hourly equipment rental rate (HERR) will be determined by the following formula:

$$HERR = F \times \left[\frac{1.15 \times R}{176}\right] + HOC$$

Where: F= Adjustment Factor to R is 0.933

R= Current RRBB Monthly Rate

HOC= Hourly Operating Cost

An overhead and profit adjustment of 15 percent of the rates provided in the Rental Rate Blue Book is included in the above formula.

The hourly operating cost represents the major costs of equipment operation, such as fuel and oil, lubrication, field repairs, tires, expendable parts, and supplies.

For each piece of equipment used, whether bought or rented, the contractor shall provide the Engineer with the following information: the manufacturer's name, equipment type, year of manufacture, model number, type of fuel used, horsepower rating, attachments required, together with their size or capacity, and any further information necessary to ascertain the proper rate.

When multiple attachments are included with the rental equipment, only the attachment having the higher rental rate will be eligible for payment, provided the attachment has been approved by the Engineer as being necessary to the force account work.

Rental charges will not be allowed for tools or equipment that show a daily rate less than five dollars or for unlisted equipment that has a value of less than four hundred dollars.

The above provisions apply to approved equipment of modern design and in good working condition. The equipment shall be handled and used to provide normal output or production. Equipment that is not in good working condition or is not of proper size for efficient performance of the work may be rejected by the Engineer. Equipment ordered for force account work will be paid for until such time as the Engineer directs that the use of such equipment be discontinued or until completion of the work.

Unless otherwise specified, manufacturer's ratings and manufacturer-approved modifications shall be used to classify equipment for the determination of applicable rental rates. Equipment

which has no direct power unit shall be powered by a unit of at least the minimum rating recommended by the manufacturer.

If it is deemed necessary by the Engineer to use equipment not listed in the above publication, a suitable rate for such equipment will be established by the Engineer. The contractor may furnish cost data which might assist the Engineer in the establishment of such rental rate. The rental rates shall be agreed to in writing prior to the use of such equipment on force account work or paid for by invoices in the case of outside rented equipment.

The Rental Rate Blue Book adjustment factor (F) will be 0.933.

(b) **Stand-By Time:**

Equipment that is in operational condition and is standing by with the Engineer's approval for participation in Force Account Work shall be paid for according to the following Stand-By Rate (SBR):

$$SBR = F \times \left(\frac{R}{176} \right) \times \ 1/2$$

Payment for "stand-by" will be limited to not more than eight hours in a 24-hour day or 40 hours in a normal week. No compensation shall be allowed for equipment that is inoperable due to breakdown. No payment shall be allowed for equipment that is not operating because work has been suspended by the contractor for the contractor's reasons.

(c) **Outside Rented Equipment:**

In cases where a piece of equipment to be used is rented or leased by the contractor from a third party exclusively for force account work, the contractor will be paid as follows:

[Rental Invoice x 1.10] + HOC

The above formula includes a 10 percent markup of the rental invoice for all overhead and incidental costs for furnishing the equipment.

(d) **Moving of Equipment:**

Rental time will also be allowed for the time required to move needed equipment to the location of the force account work and to return it to its original location. Loading and transportation costs will be allowed in lieu of moving times when equipment is moved by means other than its own power. Moving time back to the original location or loading and transportation costs will not be allowed if the equipment is used at the site of the force account work on contract items or related work.

For use of equipment moved on the work exclusively for force account work, the cost of transferring the equipment to the site of the work and returning it to the original location will be allowed as specified herein as an additional item of expense.

The original location of the equipment to be hauled to the site of the work shall be agreed to by the Engineer in advance.

Where the move of the equipment is made by common carrier, the allowance will be the invoiced amount paid for the freight plus fifteen percent. If the contractor hauls the equipment with its own forces, rental will be allowed for the hauling unit plus the driver's wages and the cost of loading and unloading the equipment.

The maximum rental period for the day that the equipment is moved on the work and the day that the use of the equipment is discontinued shall be the actual time that the equipment is in operation on force account work.

(4) Superintendence:

No part of the salary or expense of anyone connected with the contractor's forces above the grade of foreman and having general supervision of the work will be included in the labor items as specified above, except when the contractor's organization is entirely occupied with force account work, in which case the salaries of the superintendent and the timekeeper may be included in the labor item specified above when the nature of the work is such that their services are required.

(5) Compensation:

The compensation as set forth above shall be received by the contractor as payment in full for work done on a force account basis. In addition, the contractor shall be paid an amount equal to 65 percent of the force account compensation times the applicable sales tax rate.

(6) Forms:

The contractor shall prepare the Weekly Force Account Detail form for each week of force account activity. The Weekly Force Account Detail form is a standardized, fillable form made available by the Department on the ADOT Construction Group’s website.

The form shall detail the labor, equipment, and material charges utilized to accomplish the force account work along with all supporting documentation. The contractor shall furnish copies of original receipts (paid invoice cost) for materials, rental equipment cost, including freight and transportation charges, copies of rental rate blue book equipment sheets and certified payrolls.

If materials used on the force account work are not specifically purchased for such work but are taken from the contractor's stock, then instead of invoices, the forms shall contain or be accompanied by an affidavit of the contractor certifying that such materials were taken from stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the contractor.

Force account work shall be tracked daily; however, the contractor shall compile no more than one full week's worth of daily records into a Weekly Force Account Detail form. Each reporting period runs from Saturday through Friday. The contractor shall submit the form within 30 calendar days of the respective week's force account performance. The completed form shall be submitted to the Engineer for review and approval. The Engineer will review the form and supporting documentation against the ADOT Inspector's Daily Force Account Reports, and will verify that the form is timely, complete, and accurate. Payment will not be made until the contractor has furnished applicable forms, detailing the costs of the force account work, including but not limited to the following information:

(a) Labor: name, classification, date, daily hours, hourly rate and fringe rate, and certified payrolls for each foreman and laborer.

(b) Equipment: dates, equipment number, description, operator name, hours used, approved stand-by hours, monthly rental rate, hourly operating cost and rental rate blue book sheets for each unit of equipment.

(c) Rental Equipment (Third Party): invoice, dates used, vendor name, description of equipment, operator name, hours used, invoice rate, hourly operating cost and rental rate blue book sheets for each rental equipment.

(d) Materials: invoice, date used, supplier name, description, quantity, unit of measure and unit cost.

(e) Transportation: freight and express charges on materials, FOB jobsite.

(7) Force Account Work by Subcontractors:

When force account work is determined by the Engineer to require specialized labor or equipment not normally utilized by the contractor, and such force account work is performed by subcontractors, the contractor will be allowed a supplemental markup of 5 percent of the subcontractor's costs plus the applicable tax and bond as specified in Subsection 109.04(D) of the specifications.

(8) Bond:

An amount of 0.5 percent of the total amount will be added for the Performance and Payment Bond.

(E) Non-Allowable Charges:

If the contractor chooses to accept Force Account, then the contractor's compensation in any Supplemental Agreement will only be for what is stated in the above Force Account provisions.

Whether the amount of Supplemental Agreement negotiated is for unit price, Lump Sum Agreement or Force Account, in no case will the contractor be reimbursed for the following items:

(1) Profit in excess of that provided herein;

(2) Loss of profit;

(3) Home office overhead;

(4) Consequential damages, including loss of bonding capacity, loss of bidding opportunities, and insolvency;

(5) Indirect costs or expenses of any nature;

(6) Attorneys fees, claims preparation expenses or costs of litigation; and

(7) Interest.

109.05 Eliminated Items:

The Engineer may, upon written order to the contractor, eliminate items from the contract and such action shall in no way invalidate the contract. The contractor will be compensated under the provisions of Subsection 108.11 of the specifications.

109.06 Partial Payments and Retention:

(A) Partial Payments:

If satisfactory progress is being made, the contractor will receive a payment each month based on the amount of work completed during the preceding month. The Department will prepare a draft monthly estimate for review by the contractor. The contractor shall work with the Engineer to finalize the monthly estimate. When the Engineer and the contractor have reached agreement, the final monthly estimate will be prepared and signed by the contractor and the Engineer. The contractor’s signature

constitutes a certification that the work was satisfactorily performed, meets the specifications, and the quantities reported are accurate, regardless of whether the work was performed by the contractor or a subcontractor. The Engineer will submit signed monthly estimate for payment.

Except as herein provided, the Department will not retain monies from the monthly payments.

Partial payment on either a lump sum item or on an item paid for as a unit (each) may be made if the amount of work, in the opinion of the Engineer, is of sufficient magnitude to warrant partial payment. The amount of the partial payment to be made will be in proportion to the percentage of the work completed on the item, as estimated by the Engineer.

The monthly payments will be approximate only and all partial statements and payments will be subject to correction in the final statement and payment.

If, in the opinion of the Engineer, progress is unsatisfactory after 75 percent of the contract time has expired, the Department reserves the right to withhold 10 percent of payments due the contractor until progress is determined to be satisfactory.

The acceptance of work for purposes of partial payment does not constitute final acceptance of the work.

Should any defective work or material be discovered prior to the final acceptance, the Department will deduct monies from subsequent monthly payments to provide for correction of the defective work. Payment for such defective work will not be allowed until the defect has been remedied.

(B) Subcontractor Payments:

(1) Retention:

If the prime contract does not provide for retention, the contractor and each subcontractor of any tier shall not withhold retention on any subcontract. If the prime contract provides for retention, the prime contractor and each subcontractor of any tier shall not retain a higher percentage than the Department may retain under the prime contract.

(2) No Set-offs Arising from Other Contracts:

If a subcontractor is performing work on multiple contracts for the same contractor or subcontractor of any tier, the contractor or subcontractor of any tier shall not withhold or reduce payment from its subcontractors on the contract because of disputes or claims on another contract.

(3) Partial Payment:

The contractor and each subcontractor of any tier shall make prompt partial payments to its subcontractors within seven days of receipt of payment from the Department.

(4) Final Payment:

The contractor and each subcontractor of any tier shall make prompt final payment to each of its subcontractors. The contractor and each subcontractor of any tier shall pay all monies, including retention, due to its subcontractor within seven days of receipt of payment.

(5) Payment Reporting and Sanctions:

For the purposes of this subsection "Reportable Contracts" means any subcontract, of any tier, DBE or non-DBE, by which work shall be performed on behalf of the contractor and any contract of any tier with a DBE material supplier.

The requirements of this subsection apply to all Reportable Contracts.

Payment Reporting for all Reportable Contracts shall be done through the Department's web-based DBE System. The DBE System can be accessed from the Department's SBWD website. No later than 15 calendar days after the preconstruction conference, the contractor shall log into the Department's web-based DBE System and enter or verify the name, contact information, and subcontract amounts for Reportable Contracts on the project. As Reportable Contracts are approved over the course of the contract, the contractor shall enter them in the system. Reportable contracts shall be entered into the system no later than five calendar days after approval by the Department.

The contractor shall report on a monthly basis indicating the amounts actually paid and the dates of each payment under any Reportable Contract on the project. In addition, the contractor shall require that all participants in any Reportable Contract electronically verify receipt of payment on the contract by the last day of the month and the contractor shall actively monitor the Department's DBE System to ensure that the verifications are input. The contractor shall proactively work to resolve any payment discrepancies in the DBE System between payment amounts it reports and payment confirmation amounts reported by others.

The contractor shall ensure that all Reportable Contract activity is reported to the Department. This includes all lower-tier Reportable Contracts.

The contractor shall maintain records for each payment explaining the amount requested by the subcontractor, and the amount actually paid pursuant to the request, which may include but are not limited to,

estimates, invoices, pay requests, copies of checks or wire transfers, and lien waivers in support of the monthly payments in the DBE System.

The contractor shall provide information for payments made on all Reportable Contracts during the previous month by the 15th day of the current month. In the event that no payments were made during a given month, the contractor shall identify that by entering a dollar value of zero. If the contractor does not pay the full amount of any invoice from a subcontractor, the contractor shall note that and provide the reasons in the comment section of the Monthly Payment Audit of the DBE System.

For each month that the contractor fails to submit timely and complete payment information the Department will retain $5,000 as sanctions from the monies due to the contractor. After 90 consecutive days of non-reporting, the sanctions will increase to $10,000 for each subsequent month which the contractor fails to report until the information is provided. These sanctions will be in addition to all other retention or liquidated damages provided for elsewhere in the contract.

The contractor shall ensure that a copy of this Subsection is included in every Reportable Contract of every tier.

(6) Completion of Work:

A subcontractor's work is satisfactorily completed when all the tasks called for in the subcontract have been accomplished, documented, and accepted by the Department.

(7) Disputes:

If there is a discrepancy between what is reported by the contractor in the ADOT DBE System and what the subcontractor indicates an alert email will automatically be sent to the contractor. The email will be sent to the email address provided by the contractor in the Department's DBE System. It is the contractor's responsibility to ensure that the email address in the DBE System is kept current.

The contractor shall provide a verifiable explanation of the discrepancy in the DBE System as early as practicable but in no case later than seven days after the date of the alert email.

The Engineer will determine whether the contractor has acted in good faith concerning any such explanations. The Department reserves the right to request and receive documents from the contractor and all subcontractors of any tier, in order to determine whether prompt payment requirements are met.

The contractor shall implement and use the dispute resolution process outlined in the subcontract, as described in Subsection 108.01 of the specifications, to resolve payment disputes.

(8) Non-compliance:

Failure to make prompt partial payment, or prompt final payment including any retention, within the time frames established above, will result in remedies, as the Department deems appropriate, which may include but are not limited to:

(a) Sanctions. These sanctions will be in addition to all other retention or liquidated damages provided for elsewhere in the contract:

(i) The Department will withhold two times the dollar amount not paid to each subcontractor;

(ii) If full payment is made within 30 days of the Department's payment to the contractor, the amount withheld by the Department will be released; and

(iii) If full payment is made after 30 days of the Department's payment to the contractor, the Department will release 75 percent of the funds withheld. The Department will retain the remaining 25 percent of the monies withheld as sanctions.

(b) Additional Remedies. If the contractor fails to make prompt payment for three consecutive months, or any four months over the course of one project, or if the contractor fails to make prompt payment on two or more projects within 24 months, the Department may, in addition, invoke the following remedies:

(i) Withhold monthly progress payments until the issue is resolved and full payment has been made to all subcontractors, subject to the sanctions described in paragraph (a) above;

(ii) Terminate the contract for default in accordance with Subsection 108.10 of the specifications; and/or

(iii) Disqualify the contractor from future bidding, temporarily or permanently, depending on the number and severity of violations.

In determining whether sanctions will be assessed, the extent of the sanctions, or additional remedies assessed, the State Construction Engineer will consider whether there have been other violations on this or other contracts, whether the failure to make prompt payment was due to circumstances beyond the contractor's control, and other

circumstances. The contractor may, within 15 calendar days of receipt of the decision of the State Construction Engineer, escalate the decision to the State Engineer. If the contractor does not escalate the decision of the State Construction Engineer, in writing to the State Engineer, within 15 calendar days of receipt of the decision, the contractor will be deemed to have accepted the decision and there will be no further remedy for the contractor. If the contractor escalates the decision to the State Engineer, and the contractor does not agree with the State Engineer's decision, the contractor may initiate litigation, arbitration or mediation pursuant to Subsection 105.21(D) and (E) of the specifications.

109.07 Partial Payment for Material on Hand:

Materials listed below may be considered for partial payment without the execution of a supplemental agreement, when the materials are delivered and stockpiled or produced on the project site or on another site approved by the Engineer. Such partial payment will be made at the contract unit price for the quantity of material on hand multiplied by the Partial Payment Factor.

Partial Payment	
Type of Material	**Factor**
Aggregate Subbase	0.45
Aggregate Base	0.60
Mineral Aggregate	0.40
Cover Material	0.35
Structural Steel	0.60
Reinforcing Steel	0.60
Corrugated Metal Pipe	0.50
Structural Plate Pipe or Pipe-Arch	0.65
Concrete Pipe	0.45
Flared End Section for Pipe Culvert	0.70
Cattle Guard Grill	0.60
Guardrail (Rail and Brackets)	0.50
Guardrail (Posts)	0.20
Fencing (Posts and Wire)	0.40
Precast Concrete Bridge Members (after curing period is completed)	0.80
Vertical Support for Breakaway Sign	0.60
Perforated Sign Posts	0.50
Cantilever and Bridge Sign Structures	0.60

Partial Payment	
Type of Material	**Factor**
Sign Panel	0.40

Material for items of work, whether shown above or not, may be considered for partial payment without the execution of a supplemental agreement, when the materials are delivered and stockpiled or produced on the project site or on another site approved by the Engineer. Such partial payment will be made at 100 percent of invoice cost, but shall not exceed 80 percent of the total item bid amount.

Partial payment will be made only if the material is approved by the Engineer and if satisfactory progress is being made on the contract work by the contractor.

No partial payment will be made for living or perishable plant materials until they are planted.

Partial payments will not be made on items until all required certificates of compliance have been provided.

109.08 Blank:

109.09 Acceptance and Final Payment:

When final acceptance has been made in accordance with the requirements of Subsection 105.20 of the specifications, the Engineer will prepare the final estimate of quantities of the various items of work performed.

Final payment will be made in accordance with the Engineer's final statement of the total amount earned by the contractor.

The final payment will not be made until all quantities have been checked and verified. The final payment will generally not be made before 60 days after the date of final acceptance of the work by the Engineer, although final payment may be made in 60 days or less at the sole discretion of the Department, but only when all quantities have been checked and verified.

The cost of any work, material, equipment or incidental specified in the Division I, for which no direct payment has been specified in the proposal, shall be considered as included in the contract unit price for one or more of the contract items.

109.10 Lump Sum Payment for Structures:

(A) General:

If the Bidding Schedule contains items shown with an alpha suffix and the alpha suffix is listed in the Special Provisions, the contractor will be paid on a lump sum basis.

Bidders shall specify a unit price and an extended amount for each item within the lump sum structure or group of structures for which a quantity is given. No separate total for each structure will be shown on the bidding schedule. The lump sum amount shall be the total of the extended amounts for all items related to each structure or group of structures as designated by the same alpha or numeric suffix, except for driven piles, caissons, and drilled shafts, which will be paid for under their respective contract items.

Bidders shall verify the accuracy and completeness of the quantities listed in the Bidding Schedule, and bid prices shall reflect the cost of quantities which the contractor determines to be necessary to construct the structure(s) and shall also include any additional costs for work necessary to complete the structure(s) but for which no bid quantities are listed.

(B) Adjustments Due to Quantity Variations:

For all items of work, other than the Structural Concrete, Structural Steel, Reinforcing Steel, Structural Excavation, and Structure Backfill items, no adjustment to the Bidding Schedule's, quantities, unit prices, and extended amounts will be made following the award of contract because of any errors or omissions made either by the Department in its calculations of quantities or by the contractor in its calculations.

Adjustments in the Bidding Schedule quantities for Structural Concrete, Structural Steel, Reinforcing Steel, Structural Excavation, and Structure Backfill may be initiated by the contractor or the Engineer if evidence indicates that the required quantity varies by an amount greater than five percent of the Bidding Schedule quantity. The contractor shall advise the Engineer in writing, submitting such evidence and requesting an adjustment of the quantities. The Engineer will determine the amount of adjustment, if any. The quantity upon which payment will be based will be the Bidding Schedule quantity plus or minus only that portion of the adjustment that exceeds five percent of the Bidding Schedule quantity. No adjustment to contract time will be allowed due to lump sum structure quantity variations.

(C) Adjustments Due to Revisions Ordered by the Engineer:

If the Engineer orders a revision in the project plans or specifications for a specific structure or group of structures contracted under this provision and the revision affects work for which Bidding Schedule items have been established, each item affected shall be considered a major item, and the unit price shall be subject to revision in accordance with the requirements of Subsection 104.02 of the specifications. Payment to the contractor will be adjusted by an amount equal to the product of

the quantity adjustment and the unit price bid or the revised unit price as appropriate.

If the revisions affect work for which no Bid Item has been established, payment for this work will be made in accordance with the requirements of Subsection 104.02 of the specifications.

(D) Payment:

Payment for all work necessary to construct the structure(s), including but not necessarily limited to all excavating, backfilling, foundations, concrete, reinforcing steel, structural steel, expansion joints, bearings, approach slabs, post tensioning systems, handrails, and utility and lighting conduit systems, will be made on the basis of the lump sum amount as calculated by adding the extended amounts for all related bid items designated with the same alpha or numeric suffix, except as may be adjusted in accordance with Subsections 109.10(B) and (C) of the specifications.

Driven piles, caissons, and drilled shafts will be paid for under the respective contract items and will not be paid for under lump sum payment for structures.

Partial payments will be made in accordance with the requirements of Subsection 109.06 of the specifications, on the basis of the quantities shown in the Bidding Schedule for each structure and the respective unit prices. At least five days prior to the closing date scheduled for monthly progress payments, the contractor shall furnish the Engineer an estimate of the quantity of each item of work shown in the Bidding Schedule for which the contractor expects to be compensated. The Engineer shall be the sole judge as to the approximate quantities of work eligible for payment in any month. The total amount of all partial payments shall equal the lump sum amount, as determined above, or adjusted as specified herein.

Payments made for structural concrete will be adjusted, in accordance with the provisions of Subsection 1006-7.03(B) of the specifications, for material which fails to meet the required 28-day compressive strength when sampled in accordance with the requirements of Subsection 1006-7 of the specifications.

109.11 Statistical Acceptance:

(A) General:

When referenced in individual specifications, this subsection will be used to determine the "Total Percentage of Lot Within UL and LL (PT)" or the "Percent of Lot Within Limits (PWL)" for statistical acceptance.

Subsection 109.11(B) of the specifications is used for asphaltic concrete. Subsection 109.11(C) of the specifications is used for

thickness of Portland cement concrete pavement, and Subsection 109.11(D) of the specifications for compressive strength of Portland cement concrete pavement.

(B) Definitions, Abbreviations, and Formulas for Determining the "Total Percentage of Lot Within UL and LL (PT)" for Asphaltic Concrete:

Target Value (TV):

Target values for gradation, asphalt cement content or asphalt-rubber content, and effective voids shall be as given in the contractor's mix design.

Average (AVE):

The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean. The average will be determined to one decimal place, except for asphalt cement content or asphalt-rubber content, which will be determined to two decimal places.

Standard Deviation (s):

The square root of the value formed by summing the squared difference between each individual test result for a measured characteristic and AVE, divided by the number of test results minus one, as shown in the equation below. The standard deviation will be determined to two decimal places.

$$s = \sqrt{\frac{\sum\left[\,(\text{Individual Test Results} - \text{AVE})^2\,\right]}{\text{Number of Tests} - 1}}$$

If the standard deviation calculated above is zero and the average of the individual test results meets the specified limits for "UL" and "LL", the determination of "QU", "QL", "PU", "PL", and "PT" as shown below will not be made; rather, the value for "PT" (Total Percent of Lot Within UL and LL) shall be "100". If the standard deviation calculated above is zero and the average of the individual test results does not meet the specified limits for "UL" and "LL", the value for "PT" shall be "0".

Upper Limit (UL):

The value above the TV of each measured characteristic which defines the upper limit of acceptable production.

Lower Limit (LL):

The value below the TV of each measured characteristic which defines the lower limit of acceptable production.

Upper Quality Index (QU):

$$QU = \frac{UL - AVE}{s}$$

The QU will be calculated to three decimal places.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

The QL will be calculated to three decimal places.

Percentage of Lot Within UL (PU):

Determined by entering the appropriate "N" value table with QU.

Percentage of Lot Within LL (PL):

Determined by entering the appropriate "N" value table with QL.

Total Percentage of Lot Within UL and LL (PT):

$$PT = (PU+PL)-100$$

(C) Definitions, Abbreviations, and Formulas for Determining the "Percent of Lot Within Limits (PWL)" for Thickness of Portland Cement Concrete Pavement:

Average (AVE): The average of the thickness measurements of the cores obtained in accordance with Subsection 401-4.04 of the specifications. The average will be determined to the nearest hundredth of an inch.

Standard Deviation (s): The square root of the value formed by summing the squared difference between the thickness measurement for each core and AVE, divided by the number of cores minus one, as shown in the equation below. The standard deviation will be determined to two decimal places.

$$s = \sqrt{\frac{\sum \left[(\text{Thickness Measurement for each Core} - AVE)^2 \right]}{\text{Number of Cores} - 1}}$$

If the standard deviation calculated above is zero and the average of the individual test results meets the specified “LL” (Lower Limit), the determination of “QL” and “PWL” as shown below will not be

made; rather, the value for “PWL” (Percent of Lot Within Limits) shall be “100”. If the standard deviation calculated above is zero and the average of the individual test results does not meet the specified Lower Limit, the value for “PWL” shall be “0”.

Lower Limit (LL): The required thickness less 0.2 inches.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

QL will be determined to three decimal places.

Percent of Lot Within Limits (PWL):

Determined by entering the appropriate "N" value table with QL.

(D) Definitions, Abbreviations, and Formulas for Determining the "Percent of Lot Within Limits (PWL)" for Compressive Strength of Portland Cement Concrete Pavement:

Average (AVE): The average of the compressive strengths of the samples. The average will be determined to the nearest whole number.

Standard Deviation (s): The square root of the value formed by summing the squared difference between the compressive strength result for each sample and AVE, divided by the number of samples minus one, as shown in the equation below. The standard deviation will be determined to the nearest whole number.

$$s = \sqrt{\frac{\sum \left[\left(\text{Compressive Strength Result for each Sample} - AVE\right)^2 \right]}{\text{Number of Samples} - 1}}$$

If the standard deviation calculated above is zero and the average of the individual test results meets the specified minimum strength “LL”, the determination of “QL” and “PWL” as shown below will not be made; rather, the value for “PWL” (Percent of Lot Within Limits) shall be “100”. If the standard deviation calculated above is zero and the average of the individual test results does not meet the specified minimum strength, the value for “PWL” shall be “0”.

Lower Limit (LL): The specified minimum strength.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

QL will be determined to three decimal places.

Percent of Lot Within Limits (PWL):

Determined by entering the appropriate "N" value table with QL.

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 3			
QU or QL	**PU, PL, or PWL**	**QU or QL**	**PU, PL, or PWL**
1.155 or More	100	0.000 to -0.017	50
1.153 to 1.154	99	-0.018 to -0.054	49
1.151 to 1.152	98	-0.055 to -0.090	48
1.148 to 1.150	97	-0.091 to -0.126	47
1.143 to 1.147	96	-0.127 to -0.162	46
1.137 to 1.142	95	-0.163 to -0.198	45
1.131 to 1.136	94	-0.199 to -0.233	44
1.123 to 1.130	93	-0.234 to -0.269	43
1.114 to 1.122	92	-0.270 to -0.304	42
1.104 to 1.113	91	-0.305 to -0.339	41
1.092 to 1.103	90	-0.340 to -0.373	40
1.080 to 1.091	89	-0.374 to -0.407	39
1.067 to 1.079	88	-0.408 to -0.441	38
1.053 to 1.066	87	-0.442 to -0.475	37
1.037 to 1.052	86	-0.476 to -0.507	36
1.021 to 1.036	85	-0.508 to -0.539	35
1.003 to 1.020	84	-0.540 to -0.571	34
0.985 to 1.002	83	-0.572 to -0.603	33
0.965 to 0.984	82	-0.604 to -0.633	32
0.945 to 0.964	81	-0.634 to -0.663	31
0.923 to 0.944	80	-0.664 to -0.693	30
0.901 to 0.922	79	-0.694 to -0.721	29
0.878 to 0.900	78	-0.722 to -0.749	28
0.854 to 0.877	77	-0.750 to -0.776	27
0.829 to 0.853	76	-0.777 to -0.802	26
0.803 to 0.828	75	-0.803 to -0.828	25
0.777 to 0.802	74	-0.829 to -0.853	24
0.750 to 0.776	73	-0.854 to -0.877	23
0.722 to 0.749	72	-0.878 to -0.900	22
0.694 to 0.721	71	-0.901 to -0.922	21
0.664 to 0.693	70	-0.923 to -0.944	20
0.634 to 0.663	69	-0.945 to -0.964	19
0.604 to 0.633	68	-0.965 to -0.984	18
0.572 to 0.603	67	-0.985 to -1.002	17
0.540 to 0.571	66	-1.003 to -1.020	16
0.508 to 0.539	65	-1.021 to -1.036	15
0.476 to 0.507	64	-1.037 to -1.052	14
0.442 to 0.475	63	-1.053 to -1.066	13
0.408 to 0.441	62	-1.067 to -1.079	12

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 3			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
0.374 to 0.407	61	-1.080 to -1.091	11
0.340 to 0.373	60	-1.092 to -1.103	10
0.305 to 0.339	59	-1.104 to -1.113	9
0.270 to 0.304	58	-1.114 to -1.122	8
0.234 to 0.269	57	-1.123 to -1.130	7
0.199 to 0.233	56	-1.131 to -1.136	6
0.163 to 0.198	55	-1.137 to -1.142	5
0.127 to 0.162	54	-1.143 to -1.147	4
0.091 to 0.126	53	-1.148 to -1.150	3
0.055 to 0.090	52	-1.151 to -1.152	2
0.018 to 0.054	51	-1.153 to -1.154	1
0.000 to 0.017	50	-1.155 or Less	0

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 4			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
1.485 or More	100	0.000 to -0.014	50
1.455 to 1.484	99	-0.015 to -0.044	49
1.425 to 1.454	98	-0.045 to -0.074	48
1.395 to 1.424	97	-0.075 to -0.104	47
1.365 to 1.394	96	-0.105 to -0.134	46
1.335 to 1.364	95	-0.135 to -0.164	45
1.305 to 1.334	94	-0.165 to -0.194	44
1.275 to 1.304	93	-0.195 to -0.224	43
1.245 to 1.274	92	-0.225 to -0.254	42
1.215 to 1.244	91	-0.255 to -0.284	41
1.185 to 1.214	90	-0.285 to -0.314	40
1.155 to 1.184	89	-0.315 to -0.344	39
1.125 to 1.154	88	-0.345 to -0.374	38
1.095 to 1.124	87	-0.375 to -0.404	37
1.065 to 1.094	86	-0.405 to -0.434	36
1.035 to 1.064	85	-0.435 to -0.464	35
1.005 to 1.034	84	-0.465 to -0.494	34
0.975 to 1.004	83	-0.495 to -0.524	33
0.945 to 0.974	82	-0.525 to -0.554	32
0.915 to 0.944	81	-0.555 to -0.584	31
0.885 to 0.914	80	-0.585 to -0.614	30
0.855 to 0.884	79	-0.615 to -0.644	29
0.825 to 0.854	78	-0.645 to -0.674	28
0.795 to 0.824	77	-0.675 to -0.704	27
0.765 to 0.794	76	-0.705 to -0.734	26
0.735 to 0.764	75	-0.735 to -0.764	25
0.705 to 0.734	74	-0.765 to -0.794	24
0.675 to 0.704	73	-0.795 to -0.824	23
0.645 to 0.674	72	-0.825 to -0.854	22
0.615 to 0.644	71	-0.855 to -0.884	21
0.585 to 0.614	70	-0.885 to -0.914	20
0.555 to 0.584	69	-0.915 to -0.944	19
0.525 to 0.554	68	-0.945 to -0.974	18

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 4			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
0.495 to 0.524	67	-0.975 to -1.004	17
0.465 to 0.494	66	-1.005 to -1.034	16
0.435 to 0.464	65	-1.035 to -1.064	15
0.405 to 0.434	64	-1.065 to -1.094	14
0.375 to 0.404	63	-1.095 to -1.124	13
0.345 to 0.374	62	-1.125 to -1.154	12
0.315 to 0.344	61	-1.155 to -1.184	11
0.285 to 0.314	60	-1.185 to -1.214	10
0.255 to 0.284	59	-1.215 to -1.244	9
0.225 to 0.254	58	-1.245 to -1.274	8
0.195 to 0.224	57	-1.275 to -1.304	7
0.165 to 0.194	56	-1.305 to -1.334	6
0.135 to 0.164	55	-1.335 to -1.364	5
0.105 to 0.134	54	-1.365 to -1.394	4
0.075 to 0.104	53	-1.395 to -1.424	3
0.045 to 0.074	52	-1.425 to -1.454	2
0.015 to 0.044	51	-1.455 to -1.484	1
0.000 to 0.014	50	-1.485 or Less	0

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 5			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
1.716 or More	100	0.000 to -0.013	50
1.637 to 1.715	99	-0.014 to -0.041	49
1.573 to 1.636	98	-0.042 to -0.069	48
1.517 to 1.572	97	-0.070 to -0.097	47
1.466 to 1.516	96	-0.098 to -0.126	46
1.418 to 1.465	95	-0.127 to -0.154	45
1.373 to 1.417	94	-0.155 to -0.182	44
1.330 to 1.372	93	-0.183 to -0.210	43
1.289 to 1.329	92	-0.211 to -0.239	42
1.249 to 1.288	91	-0.240 to -0.267	41
1.210 to 1.248	90	-0.268 to -0.296	40
1.173 to 1.209	89	-0.297 to -0.324	39
1.136 to 1.172	88	-0.325 to -0.353	38
1.100 to 1.135	87	-0.354 to -0.382	37
1.065 to 1.099	86	-0.383 to -0.411	36
1.030 to 1.064	85	-0.412 to -0.440	35
0.996 to 1.029	84	-0.441 to -0.469	34
0.962 to 0.995	83	-0.470 to -0.498	33
0.929 to 0.961	82	-0.499 to -0.527	32
0.896 to 0.928	81	-0.528 to -0.556	31
0.864 to 0.895	80	-0.557 to -0.586	30
0.832 to 0.863	79	-0.587 to -0.616	29
0.801 to 0.831	78	-0.617 to -0.646	28
0.769 to 0.800	77	-0.647 to -0.676	27
0.738 to 0.768	76	-0.677 to -0.707	26
0.708 to 0.737	75	-0.708 to -0.737	25
0.677 to 0.707	74	-0.738 to -0.768	24

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 5			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
0.647 to 0.676	73	-0.769 to -0.800	23
0.617 to 0.646	72	-0.801 to -0.831	22
0.587 to 0.616	71	-0.832 to -0.863	21
0.557 to 0.586	70	-0.864 to -0.895	20
0.528 to 0.556	69	-0.896 to -0.928	19
0.499 to 0.527	68	-0.929 to -0.961	18
0.470 to 0.498	67	-0.962 to -0.995	17
0.441 to 0.469	66	-0.996 to -1.029	16
0.412 to 0.440	65	-1.030 to -1.064	15
0.383 to 0.411	64	-1.065 to -1.099	14
0.354 to 0.382	63	-1.100 to -1.135	13
0.325 to 0.353	62	-1.136 to -1.172	12
0.297 to 0.324	61	-1.173 to -1.209	11
0.268 to 0.296	60	-1.210 to -1.248	10
0.240 to 0.267	59	-1.249 to -1.288	9
0.211 to 0.239	58	-1.289 to -1.329	8
0.183 to 0.210	57	-1.330 to -1.372	7
0.155 to 0.182	56	-1.373 to -1.417	6
0.127 to 0.154	55	-1.418 to -1.465	5
0.098 to 0.126	54	-1.466 to -1.516	4
0.070 to 0.097	53	-1.517 to -1.572	3
0.042 to 0.069	52	-1.573 to -1.636	2
0.014 to 0.041	51	-1.637 to -1.715	1
0.000 to 0.013	50	-1.716 or Less	0

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 6			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
1.876 or More	100	0.000 to -0.013	50
1.750 to 1.875	99	-0.014 to -0.040	49
1.658 to 1.749	98	-0.041 to -0.067	48
1.584 to 1.657	97	-0.068 to -0.095	47
1.520 to 1.583	96	-0.096 to -0.122	46
1.461 to 1.519	95	-0.123 to -0.149	45
1.407 to 1.460	94	-0.150 to -0.177	44
1.357 to 1.406	93	-0.178 to -0.204	43
1.309 to 1.356	92	-0.205 to -0.232	42
1.264 to 1.308	91	-0.233 to -0.259	41
1.221 to 1.263	90	-0.260 to -0.287	40
1.179 to 1.220	89	-0.288 to -0.315	39
1.139 to 1.178	88	-0.316 to -0.342	38
1.100 to 1.138	87	-0.343 to -0.371	37
1.062 to 1.099	86	-0.372 to -0.399	36
1.025 to 1.061	85	-0.400 to -0.427	35
0.990 to 1.024	84	-0.428 to -0.456	34
0.955 to 0.989	83	-0.457 to -0.485	33
0.920 to 0.954	82	-0.486 to -0.514	32
0.886 to 0.919	81	-0.515 to -0.543	31
0.853 to 0.885	80	-0.544 to -0.572	30

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 6			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
0.820 to 0.852	79	-0.573 to -0.602	29
0.788 to 0.819	78	-0.603 to -0.632	28
0.756 to 0.787	77	-0.633 to -0.662	27
0.725 to 0.755	76	-0.663 to -0.693	26
0.694 to 0.724	75	-0.694 to -0.724	25
0.663 to 0.693	74	-0.725 to -0.755	24
0.633 to 0.662	73	-0.756 to -0.787	23
0.603 to 0.632	72	-0.788 to -0.819	22
0.573 to 0.602	71	-0.820 to -0.852	21
0.544 to 0.572	70	-0.853 to -0.885	20
0.515 to 0.543	69	-0.886 to -0.919	19
0.486 to 0.514	68	-0.920 to -0.954	18
0.457 to 0.485	67	-0.955 to -0.989	17
0.428 to 0.456	66	-0.990 to -1.024	16
0.400 to 0.427	65	-1.025 to -1.061	15
0.372 to 0.399	64	-1.062 to -1.099	14
0.343 to 0.371	63	-1.100 to -1.138	13
0.316 to 0.342	62	-1.139 to -1.178	12
0.288 to 0.315	61	-1.179 to -1.220	11
0.260 to 0.287	60	-1.221 to -1.263	10
0.233 to 0.259	59	-1.264 to -1.308	9
0.205 to 0.232	58	-1.309 to -1.356	8
0.178 to 0.204	57	-1.357 to -1.406	7
0.150 to 0.177	56	-1.407 to -1.460	6
0.123 to 0.149	55	-1.461 to -1.519	5
0.096 to 0.122	54	-1.520 to -1.583	4
0.068 to 0.095	53	-1.584 to -1.657	3
0.041 to 0.067	52	-1.658 to -1.749	2
0.014 to 0.040	51	-1.750 to -1.875	1
0.000 to 0.013	50	-1.876 or Less	0

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 7			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
1.983 or More	100	0.000 to -0.013	50
1.825 to 1.982	99	-0.014 to -0.039	49
1.714 to 1.824	98	-0.040 to -0.066	48
1.627 to 1.713	97	-0.067 to -0.093	47
1.553 to 1.626	96	-0.094 to -0.120	46
1.487 to 1.552	95	-0.121 to -0.147	45
1.428 to 1.486	94	-0.148 to -0.174	44
1.373 to 1.427	93	-0.175 to -0.201	43
1.321 to 1.372	92	-0.202 to -0.228	42
1.273 to 1.320	91	-0.229 to -0.255	41
1.227 to 1.272	90	-0.256 to -0.282	40
1.183 to 1.226	89	-0.283 to -0.309	39
1.141 to 1.182	88	-0.310 to -0.337	38
1.100 to 1.140	87	-0.338 to -0.365	37
1.061 to 1.099	86	-0.366 to -0.392	36

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 7			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
1.023 to 1.060	85	-0.393 to -0.420	35
0.986 to 1.022	84	-0.421 to -0.449	34
0.949 to 0.985	83	-0.450 to -0.477	33
0.914 to 0.948	82	-0.478 to -0.506	32
0.880 to 0.913	81	-0.507 to -0.535	31
0.846 to 0.879	80	-0.536 to -0.564	30
0.813 to 0.845	79	-0.565 to -0.594	29
0.780 to 0.812	78	-0.595 to -0.624	28
0.748 to 0.779	77	-0.625 to -0.654	27
0.717 to 0.747	76	-0.655 to -0.685	26
0.686 to 0.716	75	-0.686 to -0.716	25
0.655 to 0.685	74	-0.717 to -0.747	24
0.625 to 0.654	73	-0.748 to -0.779	23
0.595 to 0.624	72	-0.780 to -0.812	22
0.565 to 0.594	71	-0.813 to -0.845	21
0.536 to 0.564	70	-0.846 to -0.879	20
0.507 to 0.535	69	-0.880 to -0.913	19
0.478 to 0.506	68	-0.914 to -0.948	18
0.450 to 0.477	67	-0.949 to -0.985	17
0.421 to 0.449	66	-0.986 to -1.022	16
0.393 to 0.420	65	-1.023 to -1.060	15
0.366 to 0.392	64	-1.061 to -1.099	14
0.338 to 0.365	63	-1.100 to -1.140	13
0.310 to 0.337	62	-1.141 to -1.182	12
0.283 to 0.309	61	-1.183 to -1.226	11
0.256 to 0.282	60	-1.227 to -1.272	10
0.229 to 0.255	59	-1.273 to -1.320	9
0.202 to 0.228	58	-1.321 to -1.372	8
0.175 to 0.201	57	-1.373 to -1.427	7
0.148 to 0.174	56	-1.428 to -1.486	6
0.121 to 0.147	55	-1.487 to -1.552	5
0.094 to 0.120	54	-1.553 to -1.626	4
0.067 to 0.093	53	-1.627 to -1.713	3
0.040 to 0.066	52	-1.714 to -1.824	2
0.014 to 0.039	51	-1.825 to -1.982	1
0.000 to 0.013	50	-1.983 or Less	0

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 8			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
2.064 or More	100	0.000 to -0.012	50
1.879 to 2.063	99	-0.013 to -0.039	49
1.752 to 1.878	98	-0.040 to -0.065	48
1.656 to 1.751	97	-0.066 to -0.092	47
1.576 to 1.655	96	-0.093 to -0.118	46
1.505 to 1.575	95	-0.119 to -0.145	45
1.442 to 1.504	94	-0.146 to -0.171	44
1.383 to 1.441	93	-0.172 to -0.198	43
1.329 to 1.382	92	-0.199 to -0.225	42

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 8			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
1.279 to 1.328	91	-0.226 to -0.252	41
1.231 to 1.278	90	-0.253 to -0.279	40
1.185 to 1.230	89	-0.280 to -0.306	39
1.142 to 1.184	88	-0.307 to -0.333	38
1.100 to 1.141	87	-0.334 to -0.361	37
1.060 to 1.099	86	-0.362 to -0.388	36
1.021 to 1.059	85	-0.389 to -0.416	35
0.983 to 1.020	84	-0.417 to -0.444	34
0.946 to 0.982	83	-0.445 to -0.473	33
0.911 to 0.945	82	-0.474 to -0.501	32
0.876 to 0.910	81	-0.502 to -0.530	31
0.842 to 0.875	80	-0.531 to -0.559	30
0.808 to 0.841	79	-0.560 to -0.589	29
0.775 to 0.807	78	-0.590 to -0.618	28
0.743 to 0.774	77	-0.619 to -0.649	27
0.712 to 0.742	76	-0.650 to -0.680	26
0.681 to 0.711	75	-0.681 to -0.711	25
0.650 to 0.680	74	-0.712 to -0.742	24
0.619 to 0.649	73	-0.743 to -0.774	23
0.590 to 0.618	72	-0.775 to -0.807	22
0.560 to 0.589	71	-0.808 to -0.841	21
0.531 to 0.559	70	-0.842 to -0.875	20
0.502 to 0.530	69	-0.876 to -0.910	19
0.474 to 0.501	68	-0.911 to -0.945	18
0.445 to 0.473	67	-0.946 to -0.982	17
0.417 to 0.444	66	-0.983 to -1.020	16
0.389 to 0.416	65	-1.021 to -1.059	15
0.362 to 0.388	64	-1.060 to -1.099	14
0.334 to 0.361	63	-1.100 to -1.141	13
0.307 to 0.333	62	-1.142 to -1.184	12
0.280 to 0.306	61	-1.185 to -1.230	11
0.253 to 0.279	60	-1.231 to -1.278	10
0.226 to 0.252	59	-1.279 to -1.328	9
0.199 to 0.225	58	-1.329 to -1.382	8
0.172 to 0.198	57	-1.383 to -1.441	7
0.146 to 0.171	56	-1.442 to -1.504	6
0.119 to 0.145	55	-1.505 to -1.575	5
0.093 to 0.118	54	-1.576 to -1.655	4
0.066 to 0.092	53	-1.656 to -1.751	3
0.040 to 0.065	52	-1.752 to -1.878	2
0.013 to 0.039	51	-1.879 to -2.063	1
0.000 to 0.012	50	-2.064 or Less	0

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 9			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
2.127 or More	100	0.000 to -0.012	50
1.919 to 2.126	99	-0.013 to -0.038	49
1.781 to 1.918	98	-0.039 to -0.065	48

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 9			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
1.678 to 1.780	97	-0.066 to -0.091	47
1.592 to 1.677	96	-0.092 to -0.117	46
1.518 to 1.591	95	-0.118 to -0.144	45
1.452 to 1.517	94	-0.145 to -0.170	44
1.391 to 1.451	93	-0.171 to -0.196	43
1.335 to 1.390	92	-0.197 to -0.223	42
1.283 to 1.334	91	-0.224 to -0.250	41
1.234 to 1.282	90	-0.251 to -0.277	40
1.187 to 1.233	89	-0.278 to -0.304	39
1.143 to 1.186	88	-0.305 to -0.331	38
1.100 to 1.142	87	-0.332 to -0.358	37
1.059 to 1.099	86	-0.359 to -0.386	36
1.020 to 1.058	85	-0.387 to -0.413	35
0.981 to 1.019	84	-0.414 to -0.441	34
0.944 to 0.980	83	-0.442 to -0.469	33
0.908 to 0.943	82	-0.470 to -0.498	32
0.873 to 0.907	81	-0.499 to -0.527	31
0.838 to 0.872	80	-0.528 to -0.556	30
0.805 to 0.837	79	-0.557 to -0.585	29
0.772 to 0.804	78	-0.586 to -0.615	28
0.740 to 0.771	77	-0.616 to -0.645	27
0.708 to 0.739	76	-0.646 to -0.676	26
0.677 to 0.707	75	-0.677 to -0.707	25
0.646 to 0.676	74	-0.708 to -0.739	24
0.616 to 0.645	73	-0.740 to -0.771	23
0.586 to 0.615	72	-0.772 to -0.804	22
0.557 to 0.585	71	-0.805 to -0.837	21
0.528 to 0.556	70	-0.838 to -0.872	20
0.499 to 0.527	69	-0.873 to -0.907	19
0.470 to 0.498	68	-0.908 to -0.943	18
0.442 to 0.469	67	-0.944 to -0.980	17
0.414 to 0.441	66	-0.981 to -1.019	16
0.387 to 0.413	65	-1.020 to -1.058	15
0.359 to 0.386	64	-1.059 to -1.099	14
0.332 to 0.358	63	-1.100 to -1.142	13
0.305 to 0.331	62	-1.143 to -1.186	12
0.278 to 0.304	61	-1.187 to -1.233	11
0.251 to 0.277	60	-1.234 to -1.282	10
0.224 to 0.250	59	-1.283 to -1.334	9
0.197 to 0.223	58	-1.335 to -1.390	8
0.171 to 0.196	57	-1.391 to -1.451	7
0.145 to 0.170	56	-1.452 to -1.517	6
0.118 to 0.144	55	-1.518 to -1.591	5
0.092 to 0.117	54	-1.592 to -1.677	4
0.066 to 0.091	53	-1.678 to -1.780	3
0.039 to 0.065	52	-1.781 to -1.918	2
0.013 to 0.038	51	-1.919 to -2.126	1
0.000 to 0.012	50	-2.127 or Less	0

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 10			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
2.176 or More	100	0.000 to -0.012	50
1.950 to 2.175	99	-0.013 to -0.038	49
1.803 to 1.949	98	-0.039 to -0.064	48
1.694 to 1.802	97	-0.065 to -0.090	47
1.605 to 1.693	96	-0.091 to -0.116	46
1.528 to 1.604	95	-0.117 to -0.143	45
1.459 to 1.527	94	-0.144 to -0.169	44
1.397 to 1.458	93	-0.170 to -0.195	43
1.340 to 1.396	92	-0.196 to -0.222	42
1.286 to 1.339	91	-0.223 to -0.248	41
1.236 to 1.285	90	-0.249 to -0.275	40
1.188 to 1.235	89	-0.276 to -0.302	39
1.143 to 1.187	88	-0.303 to -0.329	38
1.100 to 1.142	87	-0.330 to -0.356	37
1.059 to 1.099	86	-0.357 to -0.383	36
1.019 to 1.058	85	-0.384 to -0.411	35
0.980 to 1.018	84	-0.412 to -0.439	34
0.943 to 0.979	83	-0.440 to -0.467	33
0.906 to 0.942	82	-0.468 to -0.495	32
0.871 to 0.905	81	-0.496 to -0.524	31
0.836 to 0.870	80	-0.525 to -0.553	30
0.803 to 0.835	79	-0.554 to -0.583	29
0.770 to 0.802	78	-0.584 to -0.612	28
0.737 to 0.769	77	-0.613 to -0.643	27
0.706 to 0.736	76	-0.644 to -0.674	26
0.675 to 0.705	75	-0.675 to -0.705	25
0.644 to 0.674	74	-0.706 to -0.736	24
0.613 to 0.643	73	-0.737 to -0.769	23
0.584 to 0.612	72	-0.770 to -0.802	22
0.554 to 0.583	71	-0.803 to -0.835	21
0.525 to 0.553	70	-0.836 to -0.870	20
0.496 to 0.524	69	-0.871 to -0.905	19
0.468 to 0.495	68	-0.906 to -0.942	18
0.440 to 0.467	67	-0.943 to -0.979	17
0.412 to 0.439	66	-0.980 to -1.018	16
0.384 to 0.411	65	-1.019 to -1.058	15
0.357 to 0.383	64	-1.059 to -1.099	14
0.330 to 0.356	63	-1.100 to -1.142	13
0.303 to 0.329	62	-1.143 to -1.187	12
0.276 to 0.302	61	-1.188 to -1.235	11
0.249 to 0.275	60	-1.236 to -1.285	10
0.223 to 0.248	59	-1.286 to -1.339	9
0.196 to 0.222	58	-1.340 to -1.396	8
0.170 to 0.195	57	-1.397 to -1.458	7
0.144 to 0.169	56	-1.459 to -1.527	6
0.117 to 0.143	55	-1.528 to -1.604	5
0.091 to 0.116	54	-1.605 to -1.693	4
0.065 to 0.090	53	-1.694 to -1.802	3
0.039 to 0.064	52	-1.803 to -1.949	2

DETERMINATION OF PU, PL, or PWL Number of Tests "N" = 10			
QU or QL	PU, PL, or PWL	QU or QL	PU, PL, or PWL
0.013 to 0.038	51	-1.950 to -2.175	1
0.000 to 0.012	50	-2.176 or Less	0

109.12 Fuel Cost Adjustment:

(A) General:

The Department will adjust monthly progress payments up or down as appropriate for cost fluctuations in diesel fuel as determined in accordance with these special provisions.

A fuel cost adjustment will be made when fluctuations in the price of diesel fuel, in excess of 15 percent, occur throughout this contract. The Department will not provide such adjustments for fluctuations in the price of diesel fuel of 15 percent or less.

No adjustments will be made for fluctuations in the price of fuels other than diesel.

(B) Measurement:

The base index price of fuel will be determined by the Department from the selling prices of diesel fuel published by OPIS (Oil Price Information Service). The base index price to be used will be the price for Diesel fuel No. 2, Ultra Low Sulfur, PAD 5, City of Phoenix Rack. The reported average value for the Phoenix area will be use

The base index price for each month will be the arithmetic average of the selling price for diesel fuel, as specified above, shown in the last four reports received prior to the last Wednesday of the month.

This price will be effective as of the last Wednesday of each month, and will be posted on the Department's website, at http://www.azdot.gov/Highways/cns/bitmat.asp, on or shortly after the last Wednesday of the month.

This price may also be obtained from Contracts and Specifications Services at (602) 712 7221.

This price will be deemed to be the "initial cost" (IC) for diesel fuel on projects for which bids are opened during the following month.

The current index price for diesel fuel in subsequent months will be the base index price, determined as specified above, for the current month. For example; an adjustment for diesel fuel used in May, if applicable, will be based on the "current price" (CP) for May as posted on the last

Wednesday of May. The amount of adjustment per gallon will be the net difference between the "initial cost," adjusted by 15 percent, and the current index price. The monthly adjustment will be determined by the Engineer and included in the payment estimate as a fuel adjustment. For fluctuations in excess of 15 percent, fuel cost adjustments will only be made for current price index increases greater than 1.15 times the "initial cost" or for decreases less than 0.85 times the "initial cost." No calculation will be made for fluctuations in the current index price of 15 percent or less when compared to the "initial cost."

The number of gallons of diesel fuel used per month will be considered to equal 1.5 percent of the dollar amount of work reported by the contractor for each month. Such dollar amount will not include incentives earned by the contractor for pavement smoothness, thickness, or strength for Portland cement concrete pavements; for pavement smoothness or quality lots for asphaltic concrete pavements; for any other revenue derived from quality incentives; or for revenue accrued in the previous month for bituminous material cost fluctuations or diesel fuel price adjustments.

A monthly adjustment, if applicable, will be made on this quantity, as shown below:

$$S = \frac{0.015(Q)}{IC}\ x\ (CP - AC)$$

Where; S = Monetary amount of the adjustment (plus or minus) in dollars

Q = Dollar amount of work completed for the month

CP = Current index price in dollars per gallon

AC = Adjusted "initial cost" (1.15 or 0.85 times IC) in dollars per gallon

IC = "Initial cost" as determined above, dollars per gallon

If adjustments are made in the contract quantities, the contractor shall accept any fuel adjustment as full compensation for increases or decreases in the price of fuel regardless of the amounts of overrun or underrun.

The value calculated above (plus or minus) will be adjusted to include sales tax and other taxes as applicable.

No additional compensation will be made for any additional charges, costs, expenses, etc., which the contractor may have incurred since the time of bidding and which may be the result of any fluctuation in the base index price of diesel fuel.

No adjustments will be made for work performed after Substantial Completion, as defined in Subsection 105.19, has been achieved.

(C) Payment:

Price adjustments will be shown on the monthly progress estimate, but will not be included in the total cost of work for determination of progress or for extension of contract time.

109.13 Measurement and Payment for Asphaltic Concrete Pavement Smoothness:

(A) General:

The final asphaltic concrete pavement surface shall be tested for smoothness as specified in the Special Provisions.

When a surface treatment other than ACFC or AR ACFC, such as a chip seal coat, is to be placed on a new asphaltic concrete pavement surface as part of the project, the underlying new asphaltic concrete pavement surface will be evaluated for smoothness prior to the placement of the surface treatment.

When an ACFC or AR ACFC surface treatment is placed on a new Portland Cement Concrete Pavement (PCCP) as part of the project, the ACFC or AR-ACFC surface treatment will be evaluated for smoothness as specified herein, in addition to the PCCP smoothness requirements specified in Section 401 of the specifications.

At the completion of paving, the contractor shall notify the Engineer in writing that the pavement is ready for testing. The Engineer will then evaluate the pavement to be tested. If the Engineer determines that additional pavement preparation is required, the contractor shall perform such preparation as directed by the Engineer. The contractor shall ensure that the pavement to be tested can be driven safely at the design speed. Testing will not be performed on any portions that cannot be made safe for testing at the design speed, or on any lanes of less than 0.30 miles in length. If requested by the Engineer, the contractor shall broom the pavement immediately prior to testing. No measurement or direct payment will be made for preparing the pavement, the cost being considered as included in the price of contract items.

The Actual Smoothness Value (AS) for each 0.1 lane-mile increment will be determined, by the Department, in accordance with the provisions of Arizona Test Method 829.

Testing will not be done when the ambient air temperature is less than 40 degrees F, or during rain or other weather conditions determined to be inclement by the Engineer.

Traffic control costs during the initial smoothness testing period will be reimbursed under the provisions of Section 701 of the specifications. Any additional traffic control costs incurred, outside the normal scope of work, due to pavement repairs and subsequent pavement smoothness measurements shall be borne solely by the contractor.

The testing will be performed within ten days after the Engineer has accepted the pavement for testing. The Engineer will notify the contractor of the test results no later than 10 days after the testing has been performed.

Testing will be performed on mainline traffic lanes, and will include the full length of the pavement placed under the contract. Unless otherwise specified in the contract documents, testing of distress lanes, shoulders, ramps, tapers, cross roads, and frontage roads will not be performed.

The existing pavement smoothness values to facilitate the final surface testing evaluation will be provided in the Special Provisions, if available.

The Correction Value (CV) for the contract will be provided in the Special Provisions.

Any 0.1 lane mile increment having an Actual Smoothness Value (AS) equal to or greater than the Correction Value (CV) shall be repaired by the contractor at no additional expense to the Department.

If repairs are required, the contractor shall prepare a written proposal detailing corrective actions and submit the proposal to the Engineer within 10 working days after the contractor's receipt of test results. Within three working days, the Engineer will review the submitted proposal and either accept it, or reject it and ask for a new proposal. If rejected, the contractor shall, within 10 working days, prepare and submit a new proposal for corrective action, based on discussions with the Engineer. The Engineer will review, and either accept or reject, the new proposal within three working days of receipt.

Upon completion of any necessary repairs, the 0.1 lane mile increments containing repaired areas will be re-tested in accordance with the provisions of Arizona Test Method 829. Resultant values from re-testing will be used in determining the adjustment in payment to the contractor.

(B) Payment:

An adjustment in payment to the contractor will be as specified in the Special Provisions.

The existing smoothness values, and the values (other than AS) which are utilized in the incentive and disincentive formulas, are determined prior to the contract bid opening date and are not subject to revision or dispute after the awarding of the contract.

The total adjustment in payment to the contractor shall be the summation of the individual adjustments for the respective 0.1-lane-mile increments. The maximum total incentive allowed for the project will be specified in the Special Provisions.

For projects where pavement is removed and replaced to grade, followed by an ACFC or an AR-ACFC overlay, no smoothness measurements will be made for the following areas:

i. Pavement placed within 35 feet of the termini of the project.

ii. Pavement placed within 35 feet of the approaches and departures for bridge structures not being overlain as part of the project.

For projects where pavement is removed and replaced to grade, followed by an overlay, followed by an ACFC or an AR-ACFC overlay, no smoothness measurements will be made for the following areas:

i. Pavement placed within 100 feet of the termini of the project.

ii. Pavement placed within 100 feet of the approaches and departures for bridge structures not being overlain as part of the project.

Bridges and their approaches and departures that are overlain as part of the project will be subject to the smoothness requirements.

109.14 Blank:

109.15 Blank:

109.16 Bituminous Price Adjustment:

(A) General:

The term "bituminous material" as used herein shall include asphalt binder, asphalt rubber and emulsified asphalt.

The Department will adjust monthly progress payments as appropriate for market fluctuations in the price of bituminous material.

A price for bituminous material will be determined monthly by the Department based on the selling prices published by the Asphalt Weekly Monitor, a publication of Poten & Partners, Inc. The price will be the arithmetic average of the high and low selling prices for bituminous material shown in the previous four reports for the Arizona/Utah and Southern California regions.

This value will be effective as of the last Wednesday of each month, and will be posted on the ADOT Contracts and Specifications Group website, on or shortly after the last Wednesday of each month.

This price will be deemed the “initial cost” (IC) for bituminous material for projects on which bids are opened during the following month. This price will also be deemed the "current price" (CP) for bituminous material for the following month for projects in construction.

(B) Measurement:

For each item of bituminous material for which there is a specific pay item, and for the bituminous material used in Asphaltic Concrete mixes, an adjustment will be made for each month that a quantity of bituminous material was used on the project.

The IC for the month in which the project was bid will be compared with the CP for the appropriate current month. The CP will be as posted on the Department’s website on the last Wednesday of each month, and will be used to adjust costs for bituminous material incorporated into the job during the following month (for example; bituminous material used in May will be adjusted, as specified herein, based on the CP for May as posted on the last Wednesday of April). Any difference in price between these two values will be applied to the quantity of eligible bituminous material incorporated into the work.

Determination of the eligible quantities of bituminous material for adjustment will be based on contractor furnished invoices, except as described herein.

The tons of emulsified products to which the adjustment will be applicable will be the tons of the emulsified asphalt prior to dilution.

Adjustments in compensation for emulsified asphalts will be made at 60 percent of either the increase or decrease of IC. For emulsified asphalts containing polymer, adjustments in compensation will be made at 66 percent of either the increase or decrease.

The tons of Bituminous Material (Asphalt Rubber) to which the adjustment is applicable will be 80 percent of the total quantity of the item used. The adjustment is not applicable to the 20 percent of the material which constitutes the crumb-rubber additive.

The tons of Bituminous Material (TR+) to which the adjustment is applicable will be 92 percent of the total quantity of the item used. The adjustment is not applicable to the 8 percent of the material which constitutes the crumb-rubber additive.

The tons of bituminous material in Asphaltic Concrete mixes, subject to price adjustment shall be calculated as follows, based on the approved

mix design target values and the quantity of Asphaltic Concrete placed—regardless of the actual percentage of binder incorporated:

A monthly adjustment, if applicable, will be made on this quantity, as shown below:

$$PA = (CP - IC) \times ACP \times F$$

Where: PA = Price Adjustment monetary amount (plus or minus in dollars)
CP = Current index price (dollars per ton)
IC = Initial Cost at time of bid (dollars per ton)
ACP = Asphaltic Concrete Placed (tons)
F = Eligible Asphalt Cement %

The value calculated above (plus or minus) will be adjusted to include sales tax and other taxes as applicable.

(1) For mixes without reclaimed asphalt pavement (RAP):

F = Approved Mix Design Target Asphalt Cement %

(2) For mixes with RAP:

F = Approved Mix Design Target Asphalt Cement % – Mix Design RAP Asphalt Cement contribution %

(3) For mixes using PG TR+ Terminal Blend (8 % Crumb Rubber):

F = 0.92 x (Approved Mix Design Target Asphalt Cement %)

(4) For mixes using Asphalt-Rubber Blend (20 % Crumb Rubber):

F = 0.80 x (Approved Mix Design Target Asphalt Cement %)

(5) If the quantity of Asphaltic Concrete is measured by volume, the supplemental agreement establishing the method of measurement will specify the manner in which the tons of bituminous material eligible for the adjustment is determined.

(C) Payment:

Price adjustments will be shown on the monthly progress estimate, but will not be included in the total cost of work for determination of progress or for extension of contract time.

Price adjustments will be calculated using the measurement methods described above. Only the tons of virgin asphalt binder determined by those methods will be subject to a bituminous material price adjustment.

No price adjustment will be made for the RAP binder in the mix.

No price adjustment will be made for the 8% of binder comprising crumb rubber when (TR+) is used.

No price adjustment will be made for the 20% of binder comprising crumb rubber in the asphalt-rubber material blend.

No compensation will be made for changes that may have occurred since the time of bidding and which may be the result of any increase in the IC of bituminous material.

Adjustment in unit prices of items governed by this provision will be made in the next regular monthly progress payment following actual use or application of the bituminous material.

SECTION 201 CLEARING AND GRUBBING:

201-1 Description:

The work under this section shall consist of removing and disposing of all vegetation, rubbish, debris and other objectionable matter from within the highway right-of-way, bridge construction areas, road approaches, areas through which ditches and channels are to be excavated, and such other areas as may be specified in the Special Provisions. Clearing and grubbing shall be performed in advance of grading operations and in accordance with the requirements of these specifications.

All vegetation and objects designated to remain shall be preserved from injury or defacement. Property and landscape shall be protected and restored in accordance with the requirements of Subsection 107.11 of the specifications.

201-2 Blank:

201-3 Construction Requirements:

201-3.01 Clearing and Grubbing:

The entire length of the project, to the widths specified below, shall be cleared and grubbed, unless otherwise shown on the project plans or specified in the Special Provisions.

The area above the natural ground surface shall be cleared of all vegetation, such as trees, logs, upturned stumps, roots, brush, grass, weeds, and all other objectionable material within the following limits:

(A) Highway construction areas, including structures, frontage roads, streets, ramps, road approaches, ditches and channels, and all access roads and connections that are to be constructed. Such areas shall extend to a width of 5 feet outside of structures and excavation and embankment slope lines.

(B) Areas enclosed by interchange loops and ramps.

Within the limits of clearing, the areas below the natural ground surface, except in embankment areas where the finished subgrade elevation is 5 feet or more above the natural ground, shall be grubbed to a depth necessary to remove all stumps, roots, buried logs and other objectionable material.

In embankment areas, where the subgrade is 5 feet or more above the natural ground line, all trees, stumps and roots shall be cut off not more than 1 foot above the natural ground or shall be completely

removed where a structure is to be constructed, piles are to be placed or driven, or where unsuitable material is to be removed.

Cavities resulting from the removal of stumps or other materials, except in areas to be excavated, shall be backfilled with material approved by the Engineer. The material shall be compacted to a density of not less than 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Scarred surfaces, resulting from the work, on trees and shrubs that are to remain, shall be treated with an approved asphaltum base tree paint.

Unless specified otherwise in the Special Provisions, merchantable timber and other vegetation not designated to remain shall become the property of the contractor.

In national forest areas, clearing and grubbing shall also conform to the applicable rules and regulations of the United States Forest Service in accordance with the requirements of Subsection 107.12 of the specifications.

201-3.02 Removal and Disposal of Materials:

All materials removed in clearing and grubbing shall be disposed of at locations outside of the right-of-way which are not visible from the roadway and in accordance with the requirements of Subsection 107.11 of the specifications.

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation and other debris, the contractor shall comply with the requirements of A.R.S. Title 49, Chapter 3, and with the Rules and Regulations for Air Pollution Control, Title 18, Chapter 2, Article 6, adopted by the ADEQ pursuant to the authority granted by the Arizona Administrative Code.

Burning will be permitted only after the contractor has obtained a permit from the ADEQ and from any other Federal, State, County or City Agency that may be involved.

Combustible material may be reduced to chips of a maximum thickness of 1/2 inch and disposed of in areas between the slope lines and right-of-way lines as approved by the Engineer. The chips may either be buried or distributed uniformly on the ground surface and mixed with the underlying earth to such extent that the chips will not support combustion.

The roadway and adjacent areas shall be left with a neat and finished appearance. No accumulation of material shall remain on or adjacent to the right-of-way.

201-4 Method of Measurement:

Clearing and grubbing will be measured either on a lump sum basis or by the acre. Measurement by the acre will be to the nearest tenth of an acre, measured on a horizontal plane.

201-5 Basis of Payment:

The accepted quantities of clearing and grubbing, measured as provided above, will be paid for at the contract lump sum price or by the acre as designated in the bidding schedule, including furnishing, placing, and compacting the material required to fill the cavities resulting from the removal of tree stumps or other materials.

No payment will be made for clearing and grubbing outside the specified limits, unless such work is authorized by the Engineer.

When clearing and grubbing is not included as a contract pay item, full compensation for any clearing and grubbing necessary to perform the construction operations designated on the project plans or specified in the Special Provisions shall be considered as included in the price of contract item.

SECTION 202 REMOVAL OF STRUCTURES AND OBSTRUCTIONS:

202-1 Description:

The work under this section shall consist of the removal, wholly or in part, and satisfactory disposal of all structures and obstructions within the right-of-way which have not been designated on the project plans or specified in the Special Provisions to remain, except for those structures and obstructions which are to be removed and disposed of under other items of work in the contract. The work shall also include salvaging of designated materials and backfilling the resulting cavities.

Existing structures, pavement, sidewalks, curbs, gutters, and other existing improvements which are to become an integral part of the planned improvements shall remain even though not specifically noted.

Materials removed and not designated to be salvaged or incorporated into the work shall become the property of the contractor.

202-2 Blank:

202-3 Construction Requirements:

202-3.01 General:

Bridges, culverts, and other structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate the traffic.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to commencing the new work.

Items designated to be salvaged shall be carefully stockpiled or stored by the contractor at locations designated in the Special Provisions or as directed by the Engineer.

Items which are to be salvaged or reused in the new construction and are damaged or destroyed as a result of the contractor's operations shall be repaired or replaced by the contractor at no additional cost to the Department.

Holes, cavities, trenches, and depressions resulting from the removal of structures or obstructions, except in areas to be excavated, shall be backfilled with suitable material which shall be compacted to a density of not less than 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

202-3.02 Removal of Pipe:

All removed pipe which is to be salvaged or relaid shall be cleaned of all earth and other material inside and outside prior to being stockpiled or reused. Pipe to be reused shall be stored when necessary to avoid damage or loss before relaying.

Existing pipe to be partially removed shall be cut with straight and smooth edges on a plane perpendicular to the center line of the pipe.

202-3.03 Removal of Pavement:

(A) Portland Cement Concrete Pavement:

Unless otherwise specified in the Special Provisions, concrete pavement designated on the project plans to be removed shall either be removed from the job site and disposed of at a site secured by the contractor or buried in embankment areas. If the contractor elects to bury the concrete in embankment areas, the concrete shall be broken

into pieces and placed in the embankment in accordance with the requirements of Subsection 203-10.03(A) of the specifications.

Where new construction is to join the existing concrete pavement, the pavement shall be saw cut to a true line perpendicular to the centerline of the pavement with straight vertical edges free from irregularities.

(B) Bituminous Pavement:

Unless milling is specified in the Special Provisions, all bituminous pavement designated on the project plans to be removed, shall be completely removed down to the underlying base course or subgrade. The pavement material shall be removed and become the property of the contractor to be disposed of, unless otherwise specified in the Special Provisions.

Where new construction is to join existing bituminous pavement, the existing pavement shall be cut to a true line perpendicular to the centerline of the pavement with straight vertical edges free from irregularities. The removal of asphaltic concrete at the approaches to structures shall be accomplished in a manner approved by the Engineer.

(C) Bituminous Pavement Removal by Milling:

When milling is specified, the existing asphaltic concrete shall be removed in accordance with the details shown on the project plans with equipment specifically designed to remove such material by means of grinding or chipping to a controlled line and grade. The equipment used shall be capable of removing the existing asphaltic concrete within 0.01 feet of the specified removal depth. The removal shall be accomplished in a manner which does not destroy the integrity of any asphaltic concrete pavement that remains and which does not result in a contamination of the milled asphaltic concrete with the underlying base material. If the milled material is not used on the project, it shall be removed and become the property of the contractor to be disposed of, unless otherwise specified in the Special Provisions.

Under no circumstance shall the removal of existing asphaltic concrete begin until the mix design for replacement asphaltic concrete has been approved by the Engineer.

The extent of removal of existing asphaltic concrete must be in keeping with the contractor's ability to produce, haul, place, and compact replacement asphaltic concrete so that at all times the length of open "trench" is at a minimum. If the contractor's production of replacement asphaltic concrete is stopped for any reason, the removal of asphaltic concrete shall either cease or shall be reduced. The Engineer will be the sole judge as to whether the removal shall cease or be reduced. The Engineer’s decision will be based on the reason for the stoppage in asphaltic concrete production, the expected length

of the stoppage, the type and depth of the material being removed, and the time of day.

Replacement asphaltic concrete shall be placed as soon as possible after the "trench" has been opened up. The surface on which the material is to be placed shall be uniform and free of loose material. Any exposed base material shall be compacted to the extent required by the Engineer.

The "trench" in which asphaltic concrete is being placed shall be filled before the end of each day's work and the lane shall be opened to traffic. The length of open "trench" at any one time shall not exceed two miles or half the length of the work, whichever is the lesser.

In the event of circumstances beyond the control of the contractor, such as equipment breakdown, or if the production of the replacement asphaltic concrete has been stopped by the Engineer and the contractor is unable to comply with the requirements in the preceding paragraph, the contractor shall provide and maintain such traffic control devices that the Engineer deems necessary under the circumstances in order to provide safe and efficient passage through the work zone.

If the Engineer deems it to be warranted, the Engineer will require that the contractor provide for the surface drainage of areas where the pavement surface has temporarily been removed.

Pavement, to be removed by milling, adjacent to manholes, valve boxes, small radius curbs, and other fixed objects that produce confined areas shall be removed with milling equipment specifically designed to operate in restricted areas and capable of removing asphaltic concrete of the specified thickness without damage or displacement of the adjacent object.

On projects with existing curb and gutter, any asphaltic concrete buildup in the gutter designated to be removed, shall be removed prior to the pavement removal operation by equipment and methods approved by the Engineer. The equipment and methods used shall be capable of removing the asphaltic concrete buildup without causing damage to the curb and gutter.

202-3.04 Removal of Miscellaneous Concrete:

Miscellaneous concrete shall be defined as all or portions of mortared rubble masonry, curbs, gutters, sidewalks, driveways, aprons, slope paving, island paving, retaining walls, spillways, drainage structures, concrete box culverts, foundations, footings, and all other Portland cement concrete or masonry construction, except bridges and pavement. All existing miscellaneous concrete shall be removed to a depth of at least 5 feet below finished subgrade elevation unless otherwise specified in the Special Provisions or on the project plans.

Where new concrete is to join existing concrete, the existing concrete shall be saw cut to a true line with straight vertical edges free from irregularities.

Concrete removal operations shall be performed without damage to any portion that is to remain in place. All damage to the existing concrete, which is to remain in place, shall be repaired to a condition equal to that existing prior to the beginning of removal operations. The repairing of existing concrete damaged by the contractor's operations shall be at no additional cost to the Department.

Existing reinforcement that is to be incorporated in new work shall be protected from damage and shall be thoroughly cleaned of all adhering material before being embedded in new concrete.

Concrete shall be disposed of as provided in Subsection 202-3.03(A) of the specifications.

The floors of concrete basements, pits and structures, that are not required to be removed and which are located within the roadway shall be broken in a manner that will prevent the entrapment of water.

202-3.05 Removal of Bridges:

The removal of existing bridges, either wholly or in part, shall be as shown on the project plans or as described in the specifications. Bridge removal operations shall be conducted in such a manner as to cause the least interference to public traffic.

At least 10 days before beginning bridge removal over or adjacent to public traffic or railroad property, the contractor shall submit to the Engineer details of the removal operations showing the methods and sequence of removal and equipment to be used.

When total bridge removal is specified, all materials designated for salvage, such as structural steel, structural steel members, timber, and other reusable materials shall be carefully dismantled, removed and salvaged in accordance with the requirements of Subsection 202-3.01 of the specifications. Steel members shall be match marked as directed by the Engineer.

Piling, piers, abutments, footings, and pedestals shall be removed to at least 1 foot below ground line or 5 feet below finished subgrade elevation unless specified otherwise in the Special Provisions or on the project plans.

When partial bridge removal is specified or alteration of an existing bridge requires removal of portions of the existing structure, such removal shall be performed with sufficient care as to leave the remaining portion of the structure undamaged.

In case of damage to the existing bridge structure, the contractor shall make all necessary repairs at no additional cost to the Department. Reinforcing steel extending from the remaining portion of the structure shall be protected, cleaned, and incorporated in the new portion of the structure in accordance with the details shown on the project plans or as directed by the Engineer.

Flame cutting, saw cutting, or shear cutting may be used for removing, widening, or modifying bridges provided the contractor complies with all protection, safety and damage requirements. When lead-based paint is present, the contractor shall remove a minimum of 6 inches of the paint on each side of the cutline prior to flame cutting or saw cutting. Prior to shear cutting, a minimum of 36 inches of lead-based paint shall be removed on each side of the cutline, or as determined by the Engineer. Removal and disposal of the lead-based paint shall be performed in accordance with the requirements specified in the Special Provisions.

Explosives shall not be used in bridge removal operations unless approved by the Engineer.

No removal operations shall commence until the Engineer has reviewed and approved the contractor's removal plan. If the Engineer deems the removal equipment to be unsatisfactory, the contractor shall submit a revised removal plan to the Engineer for review and approval.

Before beginning concrete removal operations involving the removal of a portion of a monolithic concrete element, a saw cut approximately 1 inch deep shall be made to a true line along the limits of removal on all faces of the element which will be visible in the completed work.

Concrete shall be disposed of per the requirements specified in Subsection 202-3.03(A) of the specifications.

202-3.06 Removal of Signs and Delineators:

Existing warning, regulatory, guide, route marker signs and delineators that are to be removed will be designated by the Engineer. The contractor shall dismantle the sign panels and delineators and remove the sign posts from the ground in such a manner as to prevent damage to the posts. The contractor shall not remove the existing signs prior to the completion of the new sign installation, but shall remove them within five working days after the installation of the new signs or as directed by the Engineer. Signs, delineators, and sign posts shall be removed and salvaged in accordance with the requirements of Subsection 202-3.01 of the specifications.

202-3.07 Removal of Embankment Curb:

The existing embankment curb, down-drain inlets, and spillway inlets, designated on the project plans to be removed, shall be removed in such a manner as to preserve the existing bituminous surfacing.

Asphaltic concrete obtained from sources approved by the Engineer shall be used to fill and repair voids on the existing pavement surface that result from the removals.

202-3.08 Removal of Fence:

All fence to be removed, shall become the property of the contractor unless designated for salvage on the project plans. If fence is designated to be removed and salvaged, all fence, including gates shall be salvaged in accordance with the requirements of Subsection 202-3.01 of the specifications.

When designated for salvage, fence and gates shall be carefully dismantled and neatly rolled or coiled. Posts shall be cleaned of all concrete and dirt.

In areas where new fence or relocated fence is to be installed, the contractor shall perform the removals in such a manner as to prevent the escape of any livestock.

202-3.09 Removal of Guardrail:

All guardrail to be removed shall become the property of the contractor unless otherwise specified on the project plans. Guardrail removal shall include complete removal of posts, concrete foundations, and foundation tubes, and subsequent backfill of the remaining holes with moist soil in compacted lifts, as approved by the Engineer.

If guardrail is designated to be removed and salvaged, the contractor shall carefully dismantle the guardrail and remove the blocks and posts in such a manner as to prevent any damage to the removed items. The guardrail, including panels, end sections, posts, and all hardware shall be salvaged in accordance with the requirements of Subsection 202-3.01 of the specifications.

202-3.10 Removal of Asbestos Material and Asbestos Concrete Pipe:

The work under this subsection consists of removal, handling, and satisfactory disposal of the asbestos materials as shown on the project plans and described in the Special Provisions in accordance with the requirements specified herein.

(A) General:

The contractor and its abatement subcontractor shall comply with 40 CFR 61, Subpart M, except that asbestos material shall be removed and disposed of in accordance with ALL provisions of 40 CFR 61.145, including "Notification Requirements" and "Procedures for Asbestos Emission Control" specified therein, regardless of the quantity of asbestos present on the project.

(B) Asbestos Abatement Subcontractor:

The contractor shall select an asbestos abatement subcontractor that has the ability to remove, manage, and dispose of asbestos materials. All individuals performing asbestos abatement related work on this contract shall possess at least one of the following certifications:

(1) AHERA Contractor/ Supervisor for asbestos abatement; or

(2) AHERA Worker Certification for all asbestos abatement workers/laborers.

The certification shall be current, and must be valid throughout the duration of the project.

The asbestos abatement subcontractor shall have three years of documented experience performing related work with the aforementioned, valid certification.

The contractor shall submit documentation of the asbestos abatement subcontractor's certifications for all employees to be working on the project and the qualifications of the firm at the preconstruction conference. The contractor's documentation of qualifications shall provide details indicating the types of relevant experience, and shall provide the number of months of each type of experience to be considered for approval.

The Engineer will approve or reject the abatement subcontractor within 10 calendar days after receipt of documentation of experience and certifications.

The contractor will not be allowed an extension in contract time for any delays to the work because of the failure of the contractor's asbestos abatement subcontractor to meet the Department's qualifications.

(C) Removal Plan:

The asbestos abatement subcontractor shall be responsible for preparation of a comprehensive removal and disposal plan (hereinafter referred to as the removal plan) for removal, handling, and disposal of the asbestos materials. The removal plan shall comply with 40 CFR 61, Subpart M, as specified above. The removal plan shall include environmental measures and worker safety and health regulations

required in OSHA and other applicable federal, state, and local requirements for the removal and disposal of asbestos material.

The contractor shall submit the removal plan to the Engineer for review a minimum of 10 working days prior to any work that will disturb the asbestos material.

The Engineer will determine if the removal plan addresses all the required elements, and will return it as approved or disapproved within 10 calendar days after receipt. The asbestos materials shall not be disturbed until the removal plan has been approved in writing by the Engineer.

(D) Compliance Responsibility:

All work involved with the removal, handling, and disposal of the asbestos materials shall be performed by the contractor's selected asbestos abatement subcontractor.

However, the contractor shall be fully responsible for the work, and for the proper disposal of the removed asbestos materials as specified herein, all in accordance with the applicable federal, state, and local standards, regulations, and requirements. The contractor shall bear the responsibility for any non-compliance, and shall hold the Department, its agents, officials, and employees harmless from all liability which may result from non-compliance with such applicable federal, state, and local standards, regulations, and requirements.

(E) Construction Requirements:

The asbestos abatement subcontractor shall supply potable water for their employees to wash their hands after handling the asbestos materials, prior to eating, drinking, or tobacco use of any kind.

The asbestos abatement subcontractor shall remove the asbestos materials in accordance with the approved removal plan. The asbestos materials shall not be abraded in any way including grinding, sanding, or heating.

The contractor shall also provide a letter and manifest certifying that the asbestos abatement subcontractor has disposed of the asbestos material in accordance with the final removal plan. Such letter and manifest shall be submitted to the Engineer within 10 working days of final disposal.

A time extension will not be granted due to the contractor's failure to comply with the requirements specified herein.

202-3.11 Removal of Lead-Based Striping and Paint Material:

SECTION 202

The work under this subsection shall consist of removing and appropriately disposing of lead-based paint materials in accordance with the requirements described herein.

The work under this subsection covers only the removal of the lead-based paint materials that is required to safely perform the work specified in the contract documents.

(A) Lead Abatement Subcontractor:

The contractor shall select a lead abatement subcontractor that has the ability to remove, manage and dispose of lead-based materials. All individuals performing lead abatement related work on this contract shall possess at least one of the following certifications:

(1) EPA Lead Supervisor for lead abatement; or

(2) EPA Lead Worker Certification for all lead abatement workers/laborers.

The certification shall be current, and must be valid throughout the duration of the project. At least one individual with EPA Lead Supervisor certification shall be on-site when lead abatement work is being performed.

The lead abatement subcontractor shall have three years of documented experience performing related work with the aforementioned, valid certification.

The contractor shall submit documentation of the lead abatement subcontractor's certifications for all employees to be working on the project and the qualifications of the firm at the preconstruction conference. The contractor's documentation of qualifications shall provide details indicating the types of relevant experience, and shall provide the number of months of each type of experience to be considered for approval.

The Engineer will approve or reject the abatement subcontractor within 10 calendar days after receipt of documentation of experience and certifications.

The contractor will not be allowed an extension in contract time for any delays to the work because of the failure of the contractor's lead abatement subcontractor to meet the Department's qualifications.

(B) Removal Plan:

The lead abatement subcontractor shall be responsible for preparation of a comprehensive removal and disposal plan (hereinafter referred to as the removal plan) for removal, handling, storage, testing, and

disposal of the lead-based paint materials. The removal plan shall also specify the proposed storage container, and the proposed location at which the removed lead-based paint materials are to be stored during testing. The removal plan shall include environmental and safety measures to comply with federal, state, and local requirements for the removal and disposal of regulated material.

The contractor shall submit the removal plan to the Engineer for review a minimum of 10 working days prior to any work that will disturb the lead-based paint materials. The Engineer will determine if the removal plan addresses all the required elements, and will return it as approved or disapproved within 10 calendar days after receipt.

(C) Compliance Responsibility:

All work involved with the removal, handling, temporary storage, testing, and disposal of the lead-based paint materials shall be performed by the contractor's lead abatement subcontractor.

However, the contractor shall be fully responsible for the work, and for the proper disposal of the removed lead-based paint materials as specified herein, all in accordance with the applicable federal, state, and local standards, regulations, and requirements, including 29 CFR, Lead Exposure in Construction, Interim Final Rule. The contractor shall bear the responsibility for any non-compliance, and shall hold the Department, its agents, officials, and employees harmless from all liability which may result from non-compliance with such applicable Federal, State, and Local standards, regulations and requirements.

(D) Construction Requirements:

The contractor shall supply potable water for their employees to wash their hands after handling the lead-based paint materials, prior to eating, drinking, or tobacco use of any kind.

The lead-abatement subcontractor shall remove the lead-based striping in accordance with the approved removal plan. The lead-based paint materials shall not be abraded in any way. The contractor will be allowed to use an approved grinding device for the removal of lead-based roadway striping

The lead-abatement subcontractor shall remove the lead-based paint materials in accordance with the approved removal plan. The lead-based paint materials shall not be abraded in any way.

The removed lead-based paint materials shall be placed in the approved storage container (barrel, roll-off, etc.) The lead abatement subcontractor shall perform the Toxicity Characteristic Leaching Procedure (TCLP) analysis on the removed lead-based paint materials. The storage container may be temporarily stored at an ADOT Maintenance facility until the final disposal determination is made.

Should the lead abatement subcontractor choose to store the container at an ADOT Maintenance facility, the removal plan shall specify which facility, and the contractor shall contact the facility supervisor to schedule delivery of the container with the removed lead-based paint materials.

After completion of the TCLP analyses, the lead abatement subcontractor shall supplement the removal plan with specific requirements for disposal of the lead-based paint materials. The contractor shall submit the revised removal plan to the Engineer for approval within 10 working days of completion of all TCLP analyses, and before disposal of the lead-based paint materials.

If the TCLP analyses indicate that the lead-based paint materials must be disposed of at a hazardous waste facility, the cost of disposal will be paid under the force account item included in the bid schedule for disposal.

If the TCLP analyses indicate that the lead-based paint materials may be disposed of as a non-hazardous construction waste, the disposal shall be included in the cost of this item.

The contractor shall also provide a letter and manifest certifying that the lead abatement subcontractor has disposed of the lead-based paint materials in accordance with the final removal plan. Such letter and manifest shall be submitted to the Engineer within 10 working days of final disposal.

The contractor shall not store the lead-based paint materials beyond the duration of the contract time. Notice of substantial completion, as specified in Subsection 105.19 of the specifications, will not be given until the lead-based paint materials are removed from the temporary storage site and properly disposed of in accordance with the removal plan, and the Engineer has received the above-referenced certification letter and manifest.

A time extension will not be granted due to the contractor's failure to comply with the requirements specified herein.

202-4 Method of Measurement:

Removal of structures and obstructions will be measured on a lump sum basis except that when the bidding schedule contains specific items under this section on a unit basis, measurement will be made by the units designated in the bidding schedule.

Removal of asbestos materials will be measured by the square foot, of the surface area that the material will be removed. Every location from which the material will be removed will be measured to the nearest 0.1 square foot. The total cumulative measurement of all the locations will be rounded up to the nearest square foot.

Removal of asbestos concrete pipe will be measured by the linear foot of pipe removed.

Removal of lead-based striping will be measured by the linear foot of stripe removed. Skips in dashed lines will not be included in the measurement.

Measurement will be made along the center line of the stripe and will be based on a 4-inch wide stripe. Measurement for stripes with an actual width greater or less than the basic 4 inches will be made by the following method:

$$\frac{\text{Actual Width of Striping (inches)} \times \text{Linear Feet}}{\text{Four (inches)}}$$

Removal of lead-based paint material will be measured on a lump sum basis.

Disposal of lead-based paint and stripe materials at a hazardous waste facility will be measured on a force account basis.

202-5 Basis of Payment:

Payment for the accepted quantities of removal of structures and obstructions will be made by lump sum or by specific removal items or by a combination of both. Payment for removal of structures and obstructions not listed in the bidding schedule, but necessary to perform the construction operations designated on the project plans or specified in the Special Provisions shall be considered as included in the prices of contract items.

No measurement or payment will be made for saw cutting, the cost being considered as included in the price of contract items.

The prices shall include all excavation and subsequent backfill incidental to the removals, the furnishing, and placing of asphaltic concrete to fill and repair voids resulting from the work under Subsection 202-3.07 of the specifications, compaction of base material resulting from the work under Subsection 202-3.03(C) of the specifications, and the salvaging, hauling, storing, and disposing of all materials as provided herein.

Payment for removal of asbestos material will be made at the contract unit price per square foot, which price shall be full compensation for the work, complete in place, including development of the removal plan, removal, handling, and disposal of the asbestos material.

Payment for removal of asbestos concrete pipe, measured as provided above, will be paid for at the contract price per linear foot for the total length of pipe removed rounded to the nearest foot, which price will be

full compensation for the work, including development of the removal plan, removal, handling, and disposal of the asbestos material.

Payment for removal of lead-based striping, measured as provided above, will be paid for at the contract price per linear foot for the total length of stripe removed rounded to the nearest foot, which price will be full compensation for the work, including development of the removal plan, removal, handling, temporary storage, testing, and, if allowed, disposal of the lead-based striping material as a non-hazardous construction waste.

Payment for removal of lead-based material will be made at the contract lump sum price, which price shall be full compensation for the work, including development of the removal plan, removal, handling, temporary storage, testing, and, if allowed, disposal of the lead-based paint material as a non-hazardous construction waste.

If the TCLP analyses indicate that the lead-based paint materials must be disposed of at a hazardous waste facility, the cost of disposal will be paid under a force account item.

For the force account work, the abatement subcontractor shall complete and submit the Subcontractor Force Account Weekly Data Sheet, available on the Department's Construction Group website. For work performed by the abatement subcontractor, the data sheet shall include the abatement subcontractor's itemized costs for labor, materials and equipment. The payment for the abatement subcontractor's labor, materials and equipment will be calculated in accordance with Subsection 109.04 of the specifications, as shown on the data sheet.

Additional costs of disposal of the lead-based paint materials will be paid based on an invoice, hereinafter called the Hazardous Waste Facility Invoice. A sum equal to 5 percent of the Hazardous Waste Facility Invoice amount will be added to the Hazardous Waste Facility Invoice amount to calculate Direct Charges.

Direct Charges = Hazardous Waste Facility Invoice x 1.05

The contractor will be allowed a supplemental markup of 5 percent of the subcontractor's costs. A Sub-total will be calculated as follows:

Sub-total = Lead Abatement Subcontractor Costs x 1.05

The Lead Abatement Subcontractor Costs are its labor, materials, equipment and direct charges.

An amount equal to 65 percent of the Sub-total, as determined above, and multiplied by the applicable sales tax rate, will be added to the Sub-total.

Finally, an amount will be added as an allowance for the Performance and Payment Bond, calculated as follows:

Bond allowance = 0.005 x [Sub-total + (0.65 x Sub-total x sales tax rate)].

The total contractor payment (TCP) will be as follows:

TCP = (Sub-total) + (0.65 x Sub-total x sales tax rate) + (Bond allowance).

SECTION 203 EARTHWORK:

203-1 Description:

The work under this section shall consist of performing all operations necessary to excavate all materials, regardless of character and subsurface conditions, from the roadway or adjacent thereto; to excavate drainage and irrigation ditches and channels; to excavate for structures, culverts, and other facilities; to furnish and place borrow material for use as specified; to construct embankments; to place backfills for structures, culverts and other facilities; to backfill holes, pits and other depressions within the roadway area; to remove and replace unsuitable material; to excavate and grade road approaches, driveways and connections; to construct dikes and berms; and to apply water for compaction, all as designated on the project plans, specified in the Special Provisions, or directed by the Engineer.

203-2 General:

Operations shall be conducted such that existing highway facilities, utilities, railroad tracks, and other nonhighway facilities which are to remain in place will not be damaged. The contractor, at its expense, shall furnish and install sheet piling, cribbing, bulkheads, shoring, or provide whatever means necessary to adequately support the facilities which are to remain, and maintain such supports until they are no longer needed. Temporary pavements, facilities, utilities, and installations shall also be protected until they are no longer required. When temporary supports and other protective means are no longer required, they shall be removed and disposed of by the contractor.

When hauling is done over highways or city streets, the loads shall comply with legal load requirements, all material shall be removed from shelf areas of vehicles in order to eliminate spilling of material, and loads shall be watered or covered to eliminate dust.

The bidding schedule quantities for roadway excavation, drainage excavation, and borrow, if applicable, will be considered to be the final quantities for payment unless adjusted in accordance with the requirements of Subsections 104.02 or 203-2.01 of the specifications.

All suitable material removed from excavated areas within the project limits shall be used in the construction of embankments and other designated areas.

203-2.01 Earthwork Adjustments:

Adjustments in the bidding schedule quantities for roadway excavation, drainage excavation, or borrow may be initiated by the contractor or the Engineer if evidence indicates that the required quantity varies by an amount greater than 5 percent of the bidding schedule quantity. The contractor shall advise the Engineer in writing, submitting evidence in the form of a construction survey or photogrammetric survey with measurement for the proposed adjustment substantiated in accordance with Subsections 203-3.04, 203-4.04 and, 203-9.04 of the specifications and requesting an adjustment in quantities. The Engineer will determine the amount of adjustment, if any. The quantity upon which payment will be based will be the bidding schedule quantity plus or minus only that portion of the adjustment that exceeds 5 percent of the bidding schedule quantity.

Should the item of earthwork to be adjusted also be a major item, as specified in Subsections 101.02 and 104.02 of the specifications, the determination as to whether the unit price may be adjusted will be based on the difference between the final quantity and the bid schedule quantity plus or minus the 5 percent tolerance.

Neither variations in shrink or swell of material from those shown on plans, nor variations of shrink or swell from contractor obtained sources will be reason for establishing a quantity adjustment.

Adjustments in earthwork quantities due to revisions ordered by the Engineer will be isolated by measurement or calculations in accordance with the requirements of Subsections 203-3.04, 203-4.04, and 203-9.04 of the specifications. The bidding schedule quantities will be adjusted by the amount of the ordered change and will not be included in any other adjustment of the bidding schedule quantities as specified in this subsection.

203-2.02 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) when specified in the Special Provisions.

At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed:

(a) Backfill production, including crusher methods, pit extraction, and washing.

(b) Stockpile management, including stacking methods, separation techniques, stockpile pad thickness, and segregation prevention.

(c) Transporting and placing, including transport technique, lift thickness, processing and mixing technique, and compaction methods.

(d) Excavation and transporting, including method of excavation and transporting methods.

(e) Embankment, including method of mixing, compaction methods, unsuitable material control, waste site, and lift thickness.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Structural Backfill			
Gradation	AASHTO T 11 AASHTO T 27	Stockpile	1 per 500 CY per Source
PI	AASHTO T 89 AASHTO T 90	Stockpile	1 per 500 CY per Source
Proctor Density	AASHTO T 99	Stockpile	1 per Source and as needed
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	In-place	1 per 200 CY, minimum 1 per lift
Subgrade			
Gradation	AASHTO T 11 AASHTO T 27	Roadway	1 per Soil Type
PI	AASHTO T 89 AASHTO T 90	Roadway	1 per Soil Type
Proctor Density	AASHTO T 99	Roadway	1 per Soil Type
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	Roadway	1 per 1,000 feet
Natural Ground for Embankment Less than 5 Feet			
Proctor Density	AASHTO T 99	In-place	1 per Soil Type
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	In-place	1 per 1,000 feet
Embankment			

Proctor Density	AASHTO T 99	In-place	1 per Soil Type
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	In-place	1 per 1,000 feet per lift
Borrow Within Three Feet of Finished Subgrade Elevation			
Gradation	AASHTO T 11 AASHTO T 27	In-place	1 per 2,000 CY
PI	AASHTO T 89 AASHTO T 90	In-place	1 per 2,000 CY

203-3 Roadway Excavation:

203-3.01 Description:

Roadway excavation shall consist of excavating, grading, and hauling all types of materials encountered in constructing the roadway, lookouts, parking areas, turnouts, driveway entrances, ditches within the roadway, and other road-related areas as designated on the plans or specified in the Special Provisions; and the placement and compaction of excavated material in embankments as provided under Subsection 203-10 of the specifications.

Roadway excavation will not include drainage excavation or structural excavation when these items are designated as separate items of work in the bidding schedule.

203-3.02 Blank:

203-3.03 Construction Requirements:

(A) General:

All roadway excavation shall be finished to a reasonably smooth, uniform surface; shall not vary by more than 0.04 feet above or below the grade established; and shall be in reasonably close conformance to the lines, dimensions and cross-sections shown on the project or established by the Engineer. When Portland Cement Concrete Pavement or Asphaltic Concrete Pavement are to be placed directly on the subgrade, the finished surface shall not vary by more than 0.02 feet above or 0.04 feet below the established grade. When roadway excavation is made in rock, the full cross-section width of the roadway between the ditches shall be over-excavated a minimum depth of 6 inches below the subgrade elevation. The over-excavated area shall be filled with embankment material satisfactory to the Engineer and compacted and finished in accordance with the requirements of the specifications. In situations where only part of the roadway section intersects areas of rock, that portion occurring in the rock zone shall be over-excavated and backfilled as specified above.

No measurement or direct payment will be made for the work in over-excavating the rock areas, or placing the embankment material, the cost being considered as included in the cost of contract items.

All suitable excavated material shall be used in the construction of embankments or in other designated areas.

No excavated material shall be wasted without the approval of the Engineer. Wasted material shall be disposed of by the contractor in a manner approved by the Engineer and in accordance with Subsection 107.11 of the specifications.

During construction, the roadway shall be maintained in a well-drained condition at all times.

The top 6 inches of the subgrade shall be compacted to a density of not less than 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer, except that, when asphaltic concrete or Portland cement concrete is to be placed directly on subgrade, the required density shall be 100 percent of the maximum density.

(B) Slopes:

Earth slopes shall be finished to reasonably smooth surfaces and shall be free of all debris and loose material. When earth slopes are to be seeded, the surface shall be finished to a loose, evenly roughened condition, in accordance with the requirements of Subsection 805-3.02(B) of the specifications.

All shattered or loosened material shall be removed from rock cut slopes.

Adjustments in slopes shall be made, as directed by the Engineer, to avoid damage to standing trees, marring weathered rock or to harmonize with existing landscape features. The transition of such adjusted slopes shall be gradual. At the intersections of cuts and fills, slopes shall be adjusted and warped to flow into each other or into the natural ground surfaces without noticeable break.

Except in rock, the intersection of roadway cut slopes with the ground surfaces shall be rounded as shown on the plans or as directed by the Engineer. Rock that is disintegrated to such an extent that it will work and handle as earth shall be considered as earth, and the slopes shall be rounded the same as earth slopes. When earth overlays a rock cut, the top of slope shall be rounded in the same manner as earth slopes.

Where directed by the Engineer, the top 6 inches of topsoil, including duff, within the limits of the rounding, shall be removed and windrowed outside of the rounding limits. After completion of the rounding of the

slope, the windrowed materials shall be uniformly spread over the rounded area.

(C) Blasting:

(1) General:

The contractor shall perform blasting operations, including the storage, handling, and use of explosives and blasting agents, in accordance with the applicable provisions of the Standard Specifications, and all other pertinent Federal, State, and local regulations. Whenever explosives are used, they shall be of such character and in such amount as is permitted by the State and local Laws and ordinances and all respective agencies having jurisdiction over explosives. The contractor is responsible for the effects, including damages, of the contractor's blasting operations on adjacent public or private property, including objects, structures, and Utilities.

The contractor shall scale all slopes for stability, regardless of excavation technique or slope finish required. Scaling of new or modified rock cuts to remove loosened and unstable material that might become dislodged shall be performed for each cut slope. Rocks or edges protruding from the exposed cut face that could affect the trajectory of falling rock by creating a launching point for materials falling from above onto a roadway shall be removed. Scaling can be achieved by either hand or mechanical means. The adequacy of rock scaling shall be determined by the Engineer.

The contractor shall minimize blast damage behind the trim line. Blast damage includes, but is not limited to, widening and loosening of the existing joints, bedding planes, or foliation of the rock mass to remain, displacement of blocks of intact rock to remain, and creation of new fractures on the slope to remain.

Detonators (blasting caps) shall be of an electronic variety. Non-electronic detonators shall not be permitted unless approved by the Engineer for instances including, but not limited to, small shots by volume or hole count/footage as recommended by the blasting consultant.

(2) Road Closures and Safety:

A road closure shall be required for all blasting operations within 1,500 feet of traffic or as otherwise determined by the Engineer. The blast distance radius may be reduced through the use of overburden placement and blast mats for instances where the blasting proximity is close to residential or commercial structures as approved by the Engineer.

Full closures for blasting shall not exceed the time specified in the Special Provisions. Blasting operations shall be performed on Monday

through Friday between the hours of 8:00 a.m. to 5:00 p.m. unless otherwise specified in the Special Provisions. Variations to this schedule are subject to the approval of the Engineer. Sufficient equipment shall be on site to quickly clear and reopen at least one lane immediately after the blast, or as otherwise directed by the Engineer. The closure period will begin when the contractor closes the roadway to traffic and will be complete when traffic in each direction begins to flow. The Engineer will document the time of the beginning and end of the closure. The roadway shall not be closed again until all queued traffic has cleared.

The contractor shall observe the entire blast area for a minimum of five minutes following a blast to guard against rock fall before commencing work in the cut.

The Engineer may prohibit or halt the contractor's blasting operations if the required slopes are not being maintained in a stable condition, or the safety and convenience of the traveling public are being jeopardized.

Clearing, scaling, or blasting operations taking place above the traveled roadway shall incorporate berms or other containment measures to control rock migration and protect the public and workers. Scaling of rock slopes adjacent to or above the roadway shall employ devices to contain and collect material for safe removal. These measures shall be implemented at no cost to the Department.

No blasting will be permitted except when the road is closed to public travel. Before blasting takes place, the blasting site and adjoining areas shall be cleared of workers and members of the public.

When night blasting is allowed, the night time frame is defined as the hours starting one-half hour after sunset until one-half hour before sunrise. For purposes of this restriction, “blasting” includes initiating explosives, clearing, and checking blast areas after blasting prior to sounding the all-clear. Special exceptions may be granted by the Engineer to mitigate misfires. If night blasting and/or loading is allowed, the entire blast area shall be illuminated from two sides so as to reduce shadows and allow clear observation of the blast area at all times. Drilling and loading (as in handling explosives) can all be completed anytime, including nighttime.

Safety of blasting and related operations is solely the responsibility of the contractor.

No blasting or pioneering shall be performed until pre-scaling and temporary support, if required, is in place.

(3) Road Maintenance:

The contractor shall patch any pavement used for travel by the public that becomes damaged as a result of blasting or mucking operations. Repair shall be completed as early as practicable after the activity that caused the damage, so as to facilitate the safe and smooth passage of traffic. The Engineer may direct that further blasting be suspended until pavement is satisfactorily patched. The contractor shall have sufficient cold patch asphaltic concrete (AC) material available to repair damaged pavement. Pavement damage resulting in potentially hazardous driving conditions shall be repaired immediately.

Any damage as a result of the blasting operations shall be repaired by the contractor at no additional cost to the Department.

(4) Blasting Proposal:

The contractor shall submit a blasting proposal for the Engineer's review and approval. The blasting proposal shall be submitted at least two weeks prior to the planned commencement of rock excavation activities. The plan shall be approved before any explosives are delivered to the site. At a minimum, the blasting proposal shall include the following information:

(a) The proposed location, excavation plan, and description of the test blasting program.

(b) The proposed sequence of excavation of the various major elements of the project.

(c) Description of equipment for scaling, drilling, blasting, pioneering, and excavating.

(d) Method of blasting, excavating, and scaling to form the desired cut slope contour including production blasting and slope finishing in accordance with the visual attainment criteria established for the project, with special note of mechanical techniques to be employed. Station limits where mass excavation will be done by mechanical equipment as opposed to blasting.

(e) Blasting sequence, timing, dimensions, cleanup approach, and burden adjustments that will meet the road closure limitations specified.

(f) Intended measures for limiting dust and controlling fly rock that may threaten any structures, utilities, the remaining existing roadway, as well the public using the area, during excavation operations.

(g) An approved proposal shall be required before any blasting operations, including the test blasts, may commence. The

Engineer will either approve the Proposal, or return it for revisions, within two weeks of receipt.

(h) Names and experience of Blasting Supervisors and Blasters in Charge. Qualifications of all supervisory and technical personnel to be involved in blasting operations. The Blasting Supervisor shall have a minimum of three years experience and completed three projects as a blasting supervisor. Any change in, or addition to, the personnel shown in the approved Proposal must be submitted to the Engineer for approval.

(i) Methods for and locations of explosives storage, delivery, and handling, a scaled drawing of the location of any magazine to be located within five miles of the Site, and name and contact information for contact person responsible for assuring the security of blasting materials and supplies stored for use on the Project.

(j) Name, address, and telephone number of all explosives suppliers, and identification of all explosives delivery vehicles and operators.

(k) Manufacturers' safety data sheets and product data sheets for all explosives, primers, and initiators to be employed.

(l) Methods Contractor shall employ for traffic control and other public safety precautions in the use, storage, and transportation of explosives.

(m) Equipment Contractor intends to use in or in support of blasting operations.

(n) Method of vibration control, vibration monitoring instrumentation, and the identity of the person or persons collecting and analyzing the data.

(o) Proposed methods to protect the public during blasting operations, including notification to the public through various media, locations and types of signage, fencing, and look-outs.

(5) Pre-Blast Condition Survey:

The contractor shall perform a pre-blast condition survey of nearby utilities, structures, and buildings that may be at risk from blasting damage. The specific utilities, structures, and buildings surveyed, as well as the survey method used, shall be acceptable to the contractor's insurance company. The contractor shall be responsible for any damage resulting from blasting. The pre-blast survey records shall be made available to the Engineer for review.

(6) Protection of Utilities:

The contractor shall comply with the requirements of nearby utility companies relative to protection of their individual utilities from the effects of blasting operations. The contractor shall also comply with the following requirements when blasting operations are within 1,000 feet of overhead power transmission line areas:

(a) The contractor shall provide written notification to relevant utility companies a minimum of ten business days prior to blasting within 1,000 feet of any transmission line.

(b) Once blasting operations have begun, the contractor shall proceed as continuously as practicable with blasting operations in that area.

(c) The contractor shall prevent fly rock when any portion of any blast is within 300 feet of the outside phase of the closest transmission line. Fly rock prevention measures include covering the entire shot with blasting mats or soil.

(7) Control of Vibrations and Air-Blast:

The contractor shall locate seismographs between the blast area and the closest susceptible object, structure, or utility. The contractor shall use seismographs whenever any part of a blast comes within 500 feet of an existing building, box culvert, retaining wall, bridge structure, pipeline, utility pole, transmission tower, or existing landslide. The Engineer may require the use of seismographs to monitor ground vibrations and/or air blast overpressure at greater distances.

The contractor shall protect all existing facilities from damage from blasting vibrations and air-blast. The contractor shall deploy and monitor an air-blast monitoring system between the main blasting area and the location(s) subject to blast damage or annoyance.

Peak particle velocity of any component of motion (radial/longitudinal, transverse, vertical) shall not exceed the safe limits of any structure subject to vibration damage.

(8) Blast Monitoring Plan:

The contractor shall prepare a Blast Monitoring Plan that includes the following elements:

(a) Types of instruments the contractor proposes for use, including seismographs and transducers for ground vibration, and sensors for air-blast.

i. Seismographs must be capable of recording ground motion particle velocity for three mutually perpendicular components of vibration in the frequency range generally found with controlled blasting.

ii. Air-blast sensors must be specifically manufactured for the purpose of making blasting noise and sound pressure measurements.

(b) Planned locations (distance and direction) of the monitoring instruments relative to blast locations.

(c) Proposed methods of adjusting blast hole patterns, detonation systems, and/or stemming to prevent venting of blasts and to bring air-blast and noise levels produced by blasting operations within applicable limits.

(d) Proposed method(s) of documenting occurrence of fly rock.

(e) Qualifications and experience of the instrument operators.

The contractor shall submit a Blast Monitoring Plan to ADOT for review and comment not later than 15 Business Days prior to the first test blast.

(9) Test Blasting:

The contractor shall perform a minimum of one test blast at each cut location where blasting is proposed, to demonstrate the adequacy of the proposed Blast Monitoring Plan and the effectiveness of the proposed fly rock control measures. Test blasts shall be a maximum of 5,000 square feet in area and shall be representative of the techniques the contractor proposes for use in full-scale blasting unless otherwise approved by the Engineer due to restrictions related to safety, ground conditions, access, or geography, or any other condition deemed restrictive to the aforementioned. Test Blasts shall meet the requirements for limiting fly rock, road closure restrictions, vibrations and air overpressures. The contractor shall prepare a Test Blast Report for each test blast. Each Test Blast Report must include the following:

(a) Details of the test blast.

(b) Locations and details of blast monitoring.

(c) Fly rock control measures.

(d) Results of ground vibration and air-blast monitoring.

(e) Video of the test blast.

(f) Documentation of fly rock, including particle sizes and travel distances.

(g) The contractor's proposed fly rock control measures based on the test blast results.

Not later than five working days after completion of each test blast, the contractor shall submit the Test Blast Report to ADOT for review and comment.

(10) Blasting Plan:

Not later than ten working days prior to commencing drilling and blasting operations, the contractor shall submit a Blasting Plan to the Engineer for review and approval. Detailed blasting plans shall be submitted to the Engineer no less than three working days prior to drilling for that individual shot layout by location and design. The Engineer shall approve the detailed blasting plan before any drilling or blasting will be permitted in the area covered by the plan. The Engineer will either approve, or return for revisions, the contractor's detailed blasting plan within two working days of receipt.

The contractor shall prepare a Blasting Plan that includes the following:

(a) Proposed plan for each shot (to be determined by the Engineer).

(b) Station limits of each proposed shot.

(c) Proposed excavation sequence for each cut for each shot.

(d) Elevations of the tops and bottoms of each lift.

(e) For each shot, scale drawings showing plan and section views of all variations of the proposed drill pattern, including clearing limits, free face, burden, blast hole spacing, drill-hole location, sub-drill depths, lift height, blast hole diameters, and blast hole angles. The contractor shall account for location and attitude of significant fracturing, rock type changes, faulting, and special circumstances in the shot design.

(f) For each shot, a loading diagram showing powder factor, type and amount of explosives, primers, initiators, and locations and heights of stemming for all substantial variations within the pattern.

(g) For each shot, the initiation method and sequence of blast holes, including delay times and delay system.

(h) Fly rock control measures for each shot.

(i) Estimated quantities of volume of rock in-place and length of both production and controlled blast drill-holes.

(j) Vibration criteria, and predicted ground motions at sensors.

(k) Seismograph placement.

The contractor shall record each blast on videotape. At the end of each month, the contractor shall submit the unedited videotape recordings to ADOT.

(11) Blasting Report:

The contractor shall prepare a Blasting Report for each blast performed, for whatever purpose including secondary blasting, that includes the following:

(a) The start and finish of drilling and loading, along with a log of actual explosive loading and any changes in pattern.

(b) A copy of the blasting shop drawing.

(c) Approximate average drilling rate, soft seams or faults, and any occurrences of water, lost circulation, voids, stuck drill steel, or other complications to drilling.

(d) Depth measurements of all production and control holes.

(e) Name of blasting supervisor and date and time of blast.

(f) Vibration and air blast records (original printout).

(g) Include the site-specific ground vibration and air overpressure (air blast) attenuation analyses developed from the blast monitoring data, incorporating the results of Test Blasts and production blasts.

(h) An attenuation analyses, updated to reflect ongoing project blasting work.

(i) Multiple attenuation analyses as needed to represent sites with variable geology.

(j) High-resolution digital video recording of each blast.

Within five working days after each blasting, the contractor shall submit a Blasting Report to the Engineer for review and approval.

(12) Aesthetics:

In areas where the project crosses land with special scenic values as determined by the administrating agency (e.g., USFS, BLM, ASL, etc.), the contractor shall prevent or remove deleterious drill-hole traces, machine scars, and marks from machine scaling or other excavation equipment in the final roadway cut faces. Deleterious conditions shall be as identified by the Engineer, and include items listed below:

(a) Individual drill-holes whose remaining traces total more than 3 feet aggregate length.

(b) Any portion of any roadway cut bearing drill-hole traces whose aggregate length totals more than 25 percent of the total length of controlled blast holes drilled to form that portion of the cut.

(c) Machine scars traceable for more than 12 feet which parallel the natural geologic structure, bedding, or principal fracture direction.

(d) Machine scars that are traceable for more than 6 feet which do not parallel the natural geologic structure, bedding or principal fracture direction.

(e) Machine scars that are approximately parallel and repetitive (groups of two or more scars).

(D) Unsuitable Material:

Material below the natural ground surface in embankment areas and below the finished subgrade elevation in excavation areas that is unsuitable shall be excavated and disposed of as directed by the Engineer.

When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use. Such suitable material shall be placed and compacted in accordance with the requirements of Subsection 203-10 of the specifications.

(E) Surplus Material:

Unless otherwise indicated on the project plans or specified in the Special Provisions, surplus excavated material shall be removed from the job site and disposed of by the contractor in a manner approved by the Engineer and in accordance with the requirements of Subsection 107.11 of the specifications.

Surplus material shall not be removed from the job site until the work specified in Subsection 203-1 of the specifications has been completed

or when approved by the Engineer. Any surplus material removed prior to the completion of the specified work, which must subsequently be replaced, shall be at no additional cost to the Department.

203-3.04 Method of Measurement:

Measurement of roadway excavation for payment will not be required unless adjustments are made in accordance with Subsection 203-2.01 of the specifications. When adjustments are required, roadway excavation will be measured by the cubic yard in the original space occupied and the volume of material removed will be computed in cubic yards by the average end area method.

Excavation originating outside of the neat lines of cut slopes as a result of necessary blasting operations will not be measured for additional payment.

203-3.05 Basis of Payment:

The quantities of roadway excavation as shown in the bidding schedule and any adjustments as specified in Subsection 203-2.01 of the specifications, will be paid for at the contract unit price per cubic yard. The price shall include full compensation for the work complete, in place, including slope rounding, blasting, hauling, stockpiling, placing, and compacting embankments, disposal of surplus material, and preparation of the subgrade in accordance with the requirements of these specifications.

Payment for removal of slides which are not deemed to be the result of carelessness on the part of the contractor will be made in accordance with the requirements of Subsection 104.02 of the specifications.

When unsuitable material is removed, as specified in Subsection 203-3.03(D) of the specifications, payment for this work will be in accordance with the requirements of Subsection 104.02 of the specifications. No adjustment to the contract unit price will be made because of increased excavation quantities resulting from the removal of unsuitable material.

203-4 Drainage Excavation:

203-4.01 Description:

Drainage excavation shall consist of the excavation of ditches, channels or waterways, except that excavation which is required to construct ditches paralleling the roadway and constituting a part of the roadway prism shall be considered as roadway excavation.

203-4.02 Blank:

203-4.03 Construction Requirements:

Ditches, channels, and waterways shall be constructed in reasonably close conformity to the lines and grades shown on the plans or as directed by the Engineer.

When directed by the Engineer to provide outfall, ditches, channels, and waterways shall be continued outside the limits of the right-of-way. Prior to performing work outside the right-of-way, the Engineer will obtain proper authorization from the property owner. All waterways shall be constructed to drain effectively.

Suitable materials from ditch, channel or waterway excavation shall be used in the construction of embankment or for other purposes as shown on the project plans or specified in the Special Provisions. Unsuitable and surplus excavation material shall be disposed of as directed by the Engineer.

203-4.04 Method of Measurement:

Measurement of drainage excavation for payment will not be required unless adjustments are made in accordance with Subsection 203-2.01 of the specifications. When adjustments are required, drainage excavation will be measured by the cubic yard in the original space occupied and the volume of material removed will be computed in cubic yards by the average end area method.

203-4.05 Basis of Payment:

The quantities of drainage excavation shown in the bidding schedule and any adjustments as specified in Subsection 203-2.01 of the specifications, will be paid for at the contract unit price per cubic yard.

The unit price per cubic yard shall include hauling, placing and compacting the excavated material to form embankments or other features shown on the plans or directed by the Engineer and disposal of all surplus excavated material.

Payment for grader ditches and crown ditches will be made as specified under Subsections 203-6 and 203-7 of the specifications, respectively.

203-5 Structural Excavation and Structure Backfill:

203-5.01 Description:

Structural excavation shall consist of the excavation and removal of all materials necessary for the construction of bridges, concrete box culverts, inlet and outlet wings, retaining walls, or other specific items designated on the project plans or in the Special Provisions as

structural excavation; the control and removal of water, the construction or installation of all facilities necessary to accomplish the work, and the subsequent removal of such facilities, except when designated on the project plans or specified in the Special Provisions to remain in place.

Structure backfill shall consist of furnishing, placing, and compacting backfill material around structures to the lines designated on the plans, specified in the Special Provisions, directed by the Engineer and as specified herein.

The work under this section includes the furnishing and installing of a geocomposite drainage system as an abutment or retaining wall drainage when specified in the plans. All geocomposite drainage materials and installation shall be as approved by the Engineer.

203-5.02 Materials:

(A) Geocomposite Drain:

The geocomposite wall drain materials shall conform to the requirements of Subsections 1014-1 and 1014-6 of the specifications.

(B) Geocomposite Packaging, Handling, and Storage:

The identification, packaging, handling, and storage of the geocomposite wall drain material shall be in accordance with ASTM D4873. Geocomposite wall drain shall be furnished in rolls, or in another acceptable manner, wrapped with a suitable protective covering to protect the fabric from mud, dirt, dust, debris or harmful ultraviolet light. The wall drain material shall be free of defects or flaws which significantly affect its physical properties at the time of delivery and installation. Each roll or package shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Geocomposite wall drain materials shall be stored on the site or at another location approved by the Engineer in a manner which protects them from the elements. If stored outdoors, the materials shall be elevated and protected with a light colored, opaque, and waterproof cover. At no time shall the geocomposite wall drain materials be exposed to direct sunlight for a period exceeding 14 days.

203-5.03 Construction Requirements:

(A) Excavation:

The contractor shall notify the Engineer sufficiently in advance of the beginning of excavation to allow measurements to be taken of the undisturbed ground. The required excavation shall then be performed

in reasonably close conformity to the lines, grades, and cross sections established by the Engineer or shown on the plans.

In lieu of providing approved shoring methods, the sides of excavations may be sloped as required by soil conditions to stabilize the sides for safe working conditions. Side slopes shall conform to the requirements specified in current OSHA regulations and be approved by the Engineer.

When structure footings, concrete box culverts, or other structures are to rest on an excavated surface other than rock and no piles are used, care shall be taken to protect the surface from water and not disturb the bottom of the excavation. If suitable material in the bottom of the excavation is disturbed or is removed for the contractor's convenience, the foundation shall be restored by the contractor, at its expense, to a condition at least equal to the undisturbed foundation as determined by the Engineer.

When material at the planned grade of the excavation is determined by the Engineer to be unsuitable, such material shall be removed to the limits directed by the Engineer and the resulting excavation backfilled with structure backfill material.

When structures are to rest on rock, the surface shall be removed to a depth sufficient to expose sound rock. The rock shall be roughly leveled or cut to steps, and the surface roughened. Any seams in the rock shall be grouted under pressure or treated as directed by the Engineer.

Where rock or other unyielding material is encountered at the planned grade of a structure and a yielding material is encountered in an adjacent area for the same structure, the unyielding material shall be removed to a minimum depth of 2 feet below grade and replaced with structure backfill conforming to the requirements of Subsection 203-5.03(B) of the specifications.

When structures are to be supported on piles, excavations shall be completed to the bottom of the footings before any piles are drilled or driven therein. When swell or subsidence results from driving piles, the contractor shall, at its expense, excavate or backfill with suitable material the footing area to the grade of the bottom of the footings as shown on the project plans.

When during the course of structural excavation, material is removed outside the designated pay limits, the contractor shall backfill said excavated areas in accordance with the requirements for structure backfill as specified herein, and no compensation will be made for the additional material or work required.

Excavated material which is suitable for and not used as structure backfill shall be used either for the construction of embankment or in

filling other areas as designated on the plans. Material which, in the opinion of the Engineer, is not suitable for use or which is deemed surplus shall be disposed of in accordance with Subsection 203-3 of the specifications.

Prior to placing concrete or masonry the area excavated shall be inspected and approved by the Engineer.

(B) Backfill:

(1) Structure Backfill:

Structure backfill material shall be selected from excavation or from a source selected by the contractor. It shall not contain frozen lumps, chunks of clay, or other objectionable material. Backfill material shall not contain salvaged asphaltic concrete materials. Backfill material to be used for metal piles or similar items of metal shall have a value of resistivity not less than 2,000 ohm-centimeters or the value shown on the plans. Backfill material shall have a pH value between 6.0 and 10.0, inclusive, when placed against metal installations, except aluminum. Backfill material shall have a pH value between 6.0 and 9.0, inclusive, when placed against aluminum installations. Backfill material shall have a pH value between 6.0 and 12.0, inclusive, when placed against installations other than metal. Tests for pH and resistivity shall be in accordance with the requirements of AASHTO T 288 and AASHTO T 289.

Structure backfill material shall conform to the following gradation (AASHTO T 11 and AASHTO T 27):

Sieve Size	Percent Passing
3 inch	100
3/4 inch	60 - 100
No. 8	35 - 80
No. 200	0 - 12

The plasticity index shall not exceed 5 when tested in accordance with the requirements of AASHTO T 90.

Structure backfill may be comprised in part of salvaged Portland cement concrete material. Structure backfill shall not contain salvaged asphaltic concrete materials.

The source of all salvaged materials shall be approved by the Engineer prior to use. Salvaged Portland cement concrete material shall not contain hazardous materials. All metal reinforcement materials shall be removed from salvaged Portland cement concrete prior to its use in structure backfill.

Salvaged Portland cement concrete material to be used in structure backfill shall be derived from crushing.

The contractor shall submit the percentage of salvaged Portland cement concrete materials intended for use to the Engineer for approval. The percentage shall not be adjusted after approval except to maintain a consistent gradation. Any significant change in the proportions must be approved by the Engineer prior to use.

A maximum of 50 percent salvaged concrete, by weight or volume, will be allowed. Changes in proportions that result in more than 50 percent salvaged concrete will not be allowed.

Structure backfill material containing salvaged Portland cement concrete materials shall be thoroughly mixed by means of a mechanical mixing device prior to placement. The mechanical mixing device shall be a pugmill-type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of soil and aggregate materials and salvaged concrete is moved in a near horizontal direction by the mixing paddles, without the aid of conveyor belts, for a distance of at least 3 feet. The rate of feed of the combined soil and aggregate materials and salvaged concrete shall not exceed the mixing device's rated capacity in tons per hour.

Structure backfill composed of soil and aggregate materials and salvaged concrete shall conform to the gradation requirements specified for structure backfill. When soil and aggregate materials are blended with salvaged concrete, the soil and aggregate portion shall conform to the pH, resistivity, and plasticity index requirements specified for structure backfill.

(2) Use of Slurry:

As an alternate to the material requirements of Structural Backfill, the Engineer may allow material conforming to the following requirements to be used in a slurry mixture in situations where the slurry will be confined by free-draining soils (AASHTO T 11 and AASHTO T 27):

Sieve Size	Percent Passing
1-1/2 inch	100
1 inch	90 - 100
No. 8	35 - 80
No. 200	0 - 8.0

The plasticity index shall not exceed 8 when tested in accordance with the requirements of AASHTO T 90.

Salvaged materials shall not be used as a slurry unless approved by the Engineer.

(3) Placement of Backfill:

All earth material which has loosened or collapsed into the excavation from the adjacent ground and all trash, forms, and loose large rock shall be removed from the excavation before backfill is placed.

Backfill material shall not be placed against the back of concrete abutments, concrete retaining walls, or cast-in-place concrete structures until the concrete has developed its full design strength.

Backfill material shall not be placed against concrete structures not designed to retain earth loads until the concrete has attained a minimum compressive strength of 2,000 pounds per square inch and in no case before 72 hours after casting. Backfill shall be placed uniformly on each side of the structure, and at all times during placement shall be not more than 2 feet above any other side.

Unless otherwise shown on the plans or designated in the Special Provisions, minor structures such as catch basins or cattle guards which are furnished as precast structures shall be placed on a layer of structure backfill at least 6 inches in depth. The layer shall have been shaped to fit the bottom surface of the precast unit and compacted to a density of not less than 100 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. At the time the unit is placed, the moisture content of the layer shall be at or near the optimum moisture as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. After the unit has been initially set in place and checked for line and grade, it shall be removed and any defects in its bearing area shall be corrected by trimming and by placing and compacting similarly moistened structure backfill. The process of removal, correction, and replacement shall continue until the imprint of the unit on the bearing area indicates essentially uniform contact, and the unit is in reasonable conformity with the lines and grades shown on the project plans.

Where a structure is located within a paved area, all backfill material above finished subgrade elevation shall conform to the requirements of the typical pavement section of the same elevations.

Backfill compacted by pneumatic or mechanical tamping devices, shall be placed in layers not more than 8 inches in depth before compaction.

Backfill material placed as a slurry shall be placed in uniform layers not exceeding 4 feet in depth. The maximum water content of the slurry mixture shall be 40 gallons of water per ton of backfill material. Aggregate slurry shall be thoroughly mixed in a mixer approved by the Engineer. Unless otherwise approved by the Engineer, the slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(D) of the specifications.

(4) Compaction of Backfill:

Each layer of structure backfill material shall be compacted to at least 100 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Backfill material may be compacted by either mechanical or pneumatic tamping devices or backfill material may be placed as a slurry. Compaction equipment or methods which may cause excessive displacement shall not be used.

If backfill is placed as a slurry, and when directed by the Engineer, the contractor shall excavate holes in the compacted slurry to the depths and at the locations designated by the Engineer. Upon completion of the tests, the contractor shall refill the excavated areas and compact the material to the required density in a manner approved by the Engineer.

(C) Geocomposite Wall Drain:

Geocomposite wall drains shall be installed on the soil side of abutment walls, retaining walls, and culvert wing walls. If shown on the plans, geocomposite wall drains shall also be installed on the soil side of culvert sidewalls. The concrete surface of the structure against which the geocomposite drain is to be placed shall be free of soil, debris, and excessive irregularities that will prevent continuous contact between the concrete surface and the drain material. The geocomposite drain shall be installed with the single fabric surface in contact with the backfill material. When the core of the geocomposite wall drain is not perforated during manufacture, perforations shall be made in the core where the wall drain will lay against a weephole or other drainage outlet. When making these perforations, the fabric shall not be damaged in any way.

Unless otherwise specified, geocomposite wall drains shall be constructed in horizontal courses and in accordance with the details shown on the plans. To prevent infiltration of the backfill material, the geocomposite material shall be firmly secured to the face, top, and sides of the wall by using adhesive or 1.5 to 2 inch long concrete nails with approved washers or wood battens of not less than 4 square inches in area. The adhesive or alignment of the core shall not affect the drainage area or downward flow within the core. The spacing of concrete nails shall be as directed by the Engineer, but shall not be more than 4 feet apart, both horizontally and vertically. When nails are utilized, there shall be at least one horizontal row of nails in each course of geocomposite.

Horizontal seams shall be formed by utilizing the 4-inch flap of geotextile fabric extending from the upper geocomposite course and lapping over the top of the fabric on the next lower course. The fabric flap shall be securely fastened to the lower fabric by means of a continuous strip of 3-inch wide, waterproof plastic tape.

Where vertical splices are necessary at the end of a geocomposite roll or panel, an 8-inch wide continuous strip of geotextile fabric may be placed, centering over the seam and continuously fastened on both sides with the 3-inch wide, waterproof plastic tape.

As an alternative method of splicing, either horizontally or vertically, rolls of geocomposite drain material may be joined together by turning back the fabric at the roll edges and interlocking the cuspations approximately 2 inches. For overlapping in this manner, the fabric is then lapped over and tightly taped beyond the seam with the 3-inch wide, waterproof tape. Interlocking of the core shall always be in the direction of water flow.

To prevent soil intrusion, all exposed edges of the geocomposite drainage core shall be covered by tucking the 4-inch fabric lap over and behind the core edge. Alternatively, a 12-inch wide strip of fabric may be utilized in the same manner, taping it to the exposed fabric 8 inches in from the edge with a continuous strip of 3-inch wide, waterproof, plastic tape and folding the remaining 4 inches over and behind the core edge.

Should the fabric become damaged during installation by tearing or puncturing, the damaged section shall be cut out and replaced completely. If, in the judgment of the Engineer, the damage is not serious enough to warrant removal, the damaged area may be repaired by overlaying with a piece of fabric, large enough to cover the damaged area and provide a 4 inch overlap on all sides, and taping it in place with 3-inch wide strips of waterproof, plastic tape.

Structural backfill operations shall be started as soon as possible after placing the geocomposite material, but in no case shall the geocomposite material be exposed to sunlight for more than 14 days after installation. Care shall be taken during the backfill operation not to damage the geotextile surface of the drain and to avoid excessive settlement of the backfill material.

203-5.04 Method of Measurement:

(A) Structural Excavation:

Structural excavation will be measured for payment by the cubic yard based on the volume calculated from the pay limits shown on the plans.

No deduction will be made from the pay quantities when the contractor elects not to excavate material which is within the pay limits shown on the plans.

Where it is necessary to excavate to a greater depth than shown on the plans for a footing, or to remove unsuitable material in accordance with the requirements of Subsection 203-5.03(A) of the specifications,

such additional excavation which is less than 3 feet below the elevation shown on the plans will be measured for payment as structural excavation.

No measurement for payment will be made of excavation required because of slides, cave-ins, silting, or filling due to the lack of support of sides, the action of the elements or the carelessness of the contractor.

No measurement for payment will be made for structural excavation when structures are to be supported on piles or drilled shafts in new embankment sections.

(B) Structure Backfill:

Structure backfill will be measured by the cubic yard of material based on the volume calculated from the pay limits shown on the plans.

203-5.05 Basis of Payment:

The accepted quantities of structural excavation and structure backfill, measured as provided above, will be paid for at the contract unit price. The price shall be full compensation for the work complete as hereinbefore specified.

Full compensation for hauling, placing, and compacting surplus structural excavation in embankments or otherwise disposing of the material shall be considered as included in the contract price paid for excavating the material.

Payment for additional excavation, where it is found necessary to excavate to a depth greater than 3 feet below the elevation shown on the plans for a footing, to treat seams in rock, or to remove unsuitable material in accordance with the requirements of Subsection 203-5.03(A) of the specifications, will be made in accordance with the provisions of Subsection 104.02 of the specifications.

No measurement or payment will be made for furnishing and installing geocomposite drains, the cost being considered as included in the cost of contract items.

203-6 Grader Ditch:

203-6.01 Description:

Grader ditch shall consist of a triangular shaped ditch as detailed on the plans, excavated and finished with a motor grader or similar type equipment.

203-6.02 Blank:

203-6.03 Construction Requirements:

Grader ditches shall be constructed at the locations designated on the plans or as directed by the Engineer.

203-6.04 Method of Measurement:

Grader ditch will be measured by the linear foot along the center line of the ditch, parallel to the ground surface.

203-6.05 Basis of Payment:

The accepted quantities of grader ditch, measured as provided above, will be paid for at the contract unit price per linear foot.

203-7 Crown Ditches:

203-7.01 Description:

Crown ditches shall consist of excavating and finishing ditches, as detailed on the plans, to intercept surface water.

203-7.02 Blank:

203-7.03 Construction Requirements:

Crown ditches shall be constructed at the locations designated on the plans or as directed by the Engineer.

203-7.04 Method of Measurement:

Crown ditches will be measured by the linear foot along the center line of the ditch, parallel to the ground surface.

203-7.05 Basis of Payment:

The accepted quantities of crown ditches, measured as provided above, will be paid for at the contract unit price per linear foot.

203-8 Crown Dike:

203-8.01 Description:

Crown dikes shall consist of placing material to the lines and grades required to intercept the flow of the surface water and to direct it down continuing slopes to an appropriate discharge point.

203-8.02 Blank:

203-8.03 Construction Requirements:

Crown dikes shall be constructed as designated on the plans or as directed by the Engineer.

The material shall be placed in layers not exceeding 8 inches in depth before compaction and compacted to a density of at least 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

203-8.04 Method of Measurement:

Crown dike will be measured by the linear foot along the center line of the dike, parallel to the ground surface.

203-8.05 Basis of Payment:

The accepted quantities of crown dike, measured as provided above, will be paid for at the contract unit price per linear foot.

203-9 Borrow:

203-9.01 Description:

The work under this section shall consist of furnishing and placing suitable and satisfactory material obtained from sites outside of the right-of-way for use in embankments, shoulders, berms, dikes, and other similar purposes. The widening of roadway cuts and ditches and similar work within the right-of-way shall be considered as roadway excavation, not borrow.

203-9.02 Materials:

Borrow shall be secured from material sources in accordance with the requirements of Section 1001 of the specifications. The material shall be of a quality suitable for the purpose intended, free of vegetation or other unsatisfactory material. Borrow placed within 3 feet of the finished subgrade elevation shall conform to the requirements of the Special Provisions.

203-9.03 Construction Requirements:

Borrow material shall be placed in accordance with the requirements of Subsection 203-10 of the specifications.

203-9.04 Method of Measurement:

Measurement of borrow for payment will not be required unless adjustments are made in accordance with Subsection 203-2.01 of the

specifications. When adjustments are required, Borrow will be documented for payment as shown in the bidding schedule by either of the two following methods:

(A) Borrow (Pit):

When the contract provides for Borrow (Pit), the borrow will be measured by the cubic yard in the original space occupied and volume of material removed will be computed in cubic yards by the average end area method.

(B) Borrow (In Place):

When the contract provides for Borrow (In Place), the borrow will be calculated by the cubic yard in the final space occupied and volume of material placed will be computed in cubic yards by the average end area method.

No measurement for payment will be made for borrow material placed prior to completion of roadway excavation, drainage excavation, or structural excavation, when such placement results in unauthorized wasting of roadway, drainage, or structural excavation materials.

203-9.05 Basis of Payment:

The quantities of borrow as shown in the bidding schedule and adjustments to same as described in Subsection 203-2.01 of the specifications, will be paid for at the contract unit price per cubic yard. The price shall be full compensation for the item complete in place, including furnishing, hauling, placing, compacting the material, and applying water.

203-10 Embankment:

203-10.01 Description:

Embankment requirements shall apply to the construction of roadway embankments, including the widening of embankment sections with surplus material and the preparation of the areas upon which embankment material is to be placed; the construction of dikes and berms; the placing and compacting of material where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits and other depressions within the roadway area, in accordance with the requirements of these specifications.

203-10.02 Materials:

(A) Metal Pile Locations:

Where metal piles are to be driven through a newly placed embankment, the embankment material within 10 feet of the pile shall have a value of resistivity not less than 2000 ohm-centimeters or the value shown on the plans, whichever is less. When resistivity is not shown on the plans, Embankment material shall have a pH value between 6.0 and 9.0, inclusive. Tests for pH and resistivity shall be in accordance with the requirements of AASHTO T 288 and AASHTO T 289.

(B) Drilled Shaft Locations:

Embankment material containing broken concrete, rock, or other solid material which is larger than 12 inches in its greatest dimension shall not be placed horizontally within 10 feet or three shaft diameters, whichever is greater, of any proposed drilled shaft.

(C) Abutment, Wingwall and Anchor Slab Locations:

Embankment material placed adjacent to bridge abutments and wingwalls, as shown on the plans or as directed by the Engineer, will be structure backfill and shall conform to the requirements specified in Subsection 203-5 of the specifications. The limits of the structure backfill material placed adjacent to abutments and wingwalls shall be as shown on the plans or as directed by the Engineer. Fill materials shall not be placed against the back of abutments or wingwalls until the concrete has reached design strength.

When anchor slabs are specified, the embankment material placed under and adjacent to the anchor slabs shall be of a cohesive nature which will allow a neat line excavation of the anchor slab lugs.

(D) Milled Asphaltic Concrete:

Unless otherwise specified in the Special Provisions, embankment material may contain up to 50 percent milled asphaltic concrete. The milled asphaltic concrete shall be thoroughly blended with soil into a homogenous mixture using motor grader mixing of windrows or other blending methods approved by the Engineer.

The contractor shall submit the percentage of milled asphaltic concrete which is intended to be used to the Engineer for approval. Production tolerances shall be controlled to within ± 5 percent of the approved percentage in order to maintain material consistency for testing. Any change in the target percentage must be approved by the Engineer prior to use.

Embankment containing milled asphaltic concrete shall meet the requirements for sampling, testing, placement, and compaction specified in Subsection 203-10.03 of the specifications.

Shoulder buildup or road surfacing identified on the plans or by the Engineer as milled asphaltic concrete will not require blending with soil.

203-10.03 Construction Requirements:

(A) Placement:

All embankments shall be constructed to a reasonably smooth and uniform surface and shall not vary by more than 0.04 feet above or below the grade established and in reasonably close conformity to the lines, dimensions, and cross sections shown on the project plans or established by the Engineer. When Portland cement concrete pavement or asphaltic concrete pavement are to be placed directly on the subgrade, the finished surface shall not vary by more than 0.02 feet above or 0.04 feet below the established grade.

All embankment material, whether from sources within the site or from borrow, to be placed within 3 feet of the finished subgrade elevation shall have a resilient modulus value equal to or greater than the design resilient modulus value for the pavement structure.

Embankment construction shall not be started until clearing and grubbing for the embankment area is completed in accordance with the requirements of Section 201 of the specifications. When embankment material is to be placed over existing bituminous surfacing, the surfacing shall be scarified prior to placing embankment material, unless otherwise directed by the Engineer. When directed by the Engineer, surplus material or unsuitable material, as specified in Subsection 203-3.03 of the specifications, shall be disposed of by flattening embankment slopes within the project limits.

In constructing embankments on hillsides, or against existing embankments or when constructing embankments one half width at a time, the slopes of the original hillside except where solid rock is encountered, the existing embankments, or the half width of new embankments shall be cut into a minimum of 6 feet horizontally, as the work is brought up in layers, in order to minimize the possibility of slippage between the existing materials and the new embankment material. The material thus cut out shall be re-compacted along with the new embankment material.

Embankment of earth material shall be placed in uniform horizontal layers not exceeding 8 inches in depth before compaction and shall be compacted in accordance with the requirements of these specifications before the next layer is placed.

When the embankment material, resulting from the required excavations, consists predominately of rock fragments of such size that the material cannot be placed in an 8-inch layer without crushing, pulverizing or further breaking down the pieces, such material may be

placed in the embankment in layers not exceeding in thickness the approximate average size of the larger rocks being excavated, but not larger than 2 feet. It may be necessary to reduce the size of the excavated material by crushing or otherwise breaking down the material in order to comply with this requirement.

The placing of individual rocks and boulders greater than 24 inches in diameter will be permitted provided they do not exceed 36 inches in maximum dimension, are carefully distributed to prevent nesting and the interstices are filled with finer material and compacted to form a dense and compact mass. Each layer shall be leveled and smoothed by evenly distributing spalls and finer fragments of rock and earthen material with suitable leveling equipment.

Embankment material containing broken concrete, rock, or other solid materials which are larger than 6 inches in greatest dimension shall be placed so that no surface of said material is within 3 feet horizontally of any planned piling, structure, pole or sign foundations, and underground conduit. No additional compensation will be allowed for the excavation and installation of any planned facility when the additional work is caused by material in excess of 6 inches within the embankment area. It may be necessary to reduce the size of the excavated material by crushing or otherwise breaking down the material in order to comply with this requirement.

Embankment material placed at bridge abutments, as specified in Subsection 203-10.03(B) of the specifications, shall have a Plasticity Index of not more than 15 when tested in accordance with AASHTO T 90. Material placed within these limits shall contain no rocks or other solid material greater than 12 inches in its largest dimension between the subgrade elevation and a depth of 7 feet. Embankments deeper than 7 feet within these limits shall contain no rocks or other solid material greater than 24 inches in its largest dimension.

Concrete with any dimension greater than 2 feet shall be removed and wasted or reduced to a maximum of 24 inches before placing in embankment.

Embankment construction shall not take place when the material is frozen or a blanket of snow prevents proper compaction of the embankment material.

When embankment slopes are to be seeded, the surface shall be finished to a loose, evenly roughened condition, in accordance with the requirements of Subsection 805-3.02(B) of the specifications.

(B) Compaction:

(1) Earth:

Each layer of the embankment material shall be compacted by rolling, tamping, or other suitable means to the specified density before the next layer is placed. Effective spreading equipment shall be used on each layer to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulation of the material shall be required to assure uniform density. The moisture content of the material shall be adjusted, if necessary, to obtain the required density. As far as practicable, construction equipment shall be continuously routed uniformly over the entire surface of each layer.

Where embankments 5 feet or less in height are to be constructed, the top 6 inches of the ground on which the embankment material is to be placed shall be compacted to a density of not less than 95 percent of the maximum density.

When embankments are to be constructed at bridge abutments, each layer of embankment material placed beneath the approach slab, anchor slab if specified, and an additional 50 feet beyond the limits of these slabs, shall be compacted to a density of not less than 100 percent of the maximum density, including the material specified in Subsection 203-10.02(C) of the specifications. Density requirements will not apply to rocky material placed within these limits, when, in the opinion of the Engineer, the specified Arizona Test Methods for density are not appropriate.

Each layer of roadbed embankment shall be compacted to a density of not less than 95 percent of the maximum density, except that when asphaltic concrete is to be placed directly on subgrade, the top 6 inches of the embankment shall be compacted to a density of not less than 100 percent of the maximum density. Embankment material placed in dikes shall be compacted to a density of not less than 95 percent of the maximum density.

All density determinations will be made in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

AASHTO T 310 shall not be used to determine the field density or moisture content of embankment material containing salvaged asphaltic concrete.

When testing embankment materials containing milled asphaltic concrete, drying to a constant weight shall be performed at a temperature of 140 ± 5 degrees F.

(2) Rock:

Density requirements will not apply to portions of embankments constructed of materials that cannot be tested by approved methods.

Rocky materials shall be placed, spread, and leveled in 24 inches thick layers, when possible, over the full width of the embankment, with sufficient earth or other fine material so deposited to fill the interstices to produce a dense compact embankment. The average dimension of the largest rock shall not exceed 24 inches. Vibratory compactors, grid, paddle-foot, vibratory rollers, or other compacting equipment approved by the Engineer shall be used for fills constructed of materials which are predominately rock.

Rolling may be omitted on any layer, or portion thereof, when, in the judgment of the Engineer, it is physically impractical. In addition to the above rolling, each layer shall be further compacted by routing the hauling equipment uniformly over the entire width of the embankment. Additional compaction of rock embankments may be required at the discretion of the Engineer.

203-10.04 Blank:

203-10.05 Basis of Payment:

No measurement for payment will be made for hauling, placing, shaping, applying water to, and compacting embankment materials.

203-11 Shoulder Build-Up:

203-11.01 Description:

The work under this section consists of furnishing, placing, shaping, and compacting shoulder build-up material along the edge of pavement in accordance with the details shown on the project plans, the requirements of the specifications, and as approved or directed by the Engineer.

203-11.02 Materials:

(A) Earthen:

Shoulder build-up material shall be obtained from excavated areas within the project limits when shown on the project plans. If no excavation is identified for shoulder buildup on the project plans, shoulder build-up material shall be obtained from off-site borrow sources.

Roadway, drainage, or structural excavation materials will require the Engineer's approval before being placed as shoulder build-up. The Engineer's determination of the suitability of these materials for use as shoulder build-up shall be final.

Borrow for shoulder build-up material shall conform to the requirements of Subsection 203-9.02 of the specifications. The gradation will be provided in the Special Provisions.

The plasticity index shall be as shown in the Special Provisions. The plasticity index shall be tested in accordance with the requirements of AASHTO T 90. The soluble salts, when tested in accordance with the requirements of Arizona Test Method 237, shall not exceed 3,000 parts per million unless the level of soluble salts in the in-place native soil exceeds 3,000 parts per million, in which case the shoulder build-up material may not exceed the level of soluble salts in the in-place native material.

(B) Milled AC:

Shoulder build-up material shall be minus 1-1/2 inch milled asphaltic concrete obtained from within the project limits. Screening will not be required; however, the Engineer's determination of the suitability of the material shall be final.

203-11.03 Construction Requirements:

(A) Placement

Shoulder build-up material shall be placed and shaped along the edge of pavement in accordance with the details shown on the project plans, the applicable requirements of Subsection 203-10.03(A) of the specifications, and as directed by the Engineer. Rubbish, debris, and other objectionable matter shall be removed prior to placement of shoulder buildup material. Vegetation shall be cleared as necessary to accommodate placement of shoulder buildup material, but minimized to the maximum extent practicable.

Prior to placing any shoulder build-up material, the contractor shall provide an inventory of all existing delineators, signs, object markers, and milepost markers to the Engineer for approval. The inventory shall indicate the type of device and milepost or station number for each item.

After placing and shaping the material, the material shall be compacted in accordance with the requirements of the specifications and as directed by the Engineer.

Shoulder build-up material placed around guardrail terminals and breakaway- or slip-bases for signing and lighting shall be immediately shaped to allow proper functioning of the supports. No material shall be placed on any signing or lighting base plates or against any sign posts.

The contractor shall also remove shoulder build-up material from pull boxes, valve and meter boxes, vaults, and any other roadway-related items located within the shoulder.

Delineators, signs, valve boxes, vaults, and all other public and private property damaged as a result of the placement of the shoulder build-up material shall be replaced by the contractor at no additional cost to the Department.

Any windrows of shoulder build-up material stockpiled along the shoulders by the contractor shall be placed and shaped, as shown on the plans, by the end of the work shift.

When the drop-off between the newly paved surface and existing shoulder is greater than 2 inches, and the adjacent shoulder build-up will not be completed before traffic is allowed on the new pavement, a temporary fillet shall be placed adjacent to the drop-off at a slope of 3:1 (horizontal to vertical). Material for the fillet shall be as specified above.

Unless otherwise approved by the Engineer, shoulder build-up shall not be placed beyond the width shown on the project plans.

Unless otherwise shown on the project plans, shoulder build-up shall not be placed along guardrail sections.

For shoulder build-up constructed from earthen materials, all suitable materials removed from excavated areas shall be used instead of borrow in the construction of shoulder build-up, unless otherwise approved by the Engineer.

(B) Compaction:

No density requirement is specified for this material; however, compaction shall be required for all areas deemed practicable by the Engineer.

The equipment type proposed for obtaining the compaction, and the extent of compaction required shall be as approved by the Engineer.

The contractor shall compact temporary slope fillets if directed by the Engineer.

203-11.04 Method of Measurement:

Shoulder build-up will be measured for payment by the linear foot. Measurement will be along the edge of pavement against which the material is placed.

Compaction of shoulder build-up, regardless of type of equipment used, will be measured by the hour for the compacting unit, but only for the time that the unit is actually used for compacting the shoulder material, except that in any half-shift during which the unit is operated for necessary compaction, measurement will be made for the full half-shift, provided that the unit is not inoperative due to breakdown or other causes determined by the Engineer to be the responsibility of the contractor.

203-11.05 Basis of Payment:

The accepted quantities of shoulder build-up, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the work, complete in place, as specified herein and as shown on the project plans.

The accepted quantities of shoulder build-up compaction, measured as provided above, will be paid for at the contract unit price per hour, which price shall be full compensation for the work complete, as herein described and specified.

No additional measurement or direct payment will be made for clearing vegetation, removing rubbish, debris, and other objectionable matter, the construction or compaction of temporary slope fillets, or for borrow used for shoulder build-up, the costs being considered as included in the price of shoulder build-up.

SECTION 204 RESHAPING AND GRADING EXISTING IMPROVEMENTS:

204-1 Description:

The work under this section shall consist of reconstructing or restoring existing dikes, berms, and median slopes, including furnishing, placing, and compacting embankment material, as required, at the locations and in accordance with the details shown on the project plans, and the requirements of these specifications.

204-2 Blank:

204-3 Construction Requirements:

Reconstructing or restoring shall be the rebuilding of existing improvements, at or near the same location, to either new lines, grades, and cross sections or to their original lines, grades, and cross sections as shown on the project plans.

The reconstruction or restoring of dikes, berms, and median slopes shall be accomplished in accordance with the same requirements as for

new work of equivalent type and character and conform to the applicable requirements of Section 203 of the specifications.

204-4 Method of Measurement:

Reshaping and grading existing improvements will be measured on a lump sum basis.

204-5 Basis of Payment:

The accepted quantities of reshaping and grading existing improvements will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place, as described and specified herein.

SECTION 205 GRADING ROADWAY FOR PAVEMENT:

205-1 Description:

The work under this section shall consist of removing pavement, excavating, removal, and disposal of excess material, furnishing and placing embankment material, and all grading, shaping and compacting of materials necessary to construct the subgrade to the lines and grades shown in the plans and as depicted by the new pavement section specified and in accordance with the requirements of these specifications.

205-2 Blank:

205-3 Construction Requirements:

205-3.01 General:

All existing pavement shall be removed as designated on the project plans. Where new asphaltic concrete is to match existing bituminous surfaces, the edges of the existing bituminous surfaces abutting the new paving shall be either saw cut or wheel cut to a minimum depth of 1-1/2 inches to form a neat true line with straight vertical edges free from irregularities. Should the contractor elect to wheel cut the edges, the cutter wheel shall be adequate for the work, in the opinion of the Engineer, to produce the desired result.

If at the time of removing any portion of the existing roadway, in-place materials from which the new subgrade is to be constructed contain an excess of moisture, so that the required compaction cannot be obtained with reasonable and customary aeration and manipulation, the Engineer will determine the cause of such condition and will determine whether the material shall be further aerated or removed and replaced.

If the cause of such condition is determined to have been unforeseeable and beyond the control of and without fault or negligence of the contractor, such further work shall be done as directed and will be paid for as extra work in accordance with the requirements of Subsection 104.02 of the specifications. Excess moisture caused by irrigation water, storm drainage, weather, breakage of mains, or other similar cause will be considered as within the responsibility of the contractor.

205-3.02 Excavation:

Excavation shall conform with the requirements of Subsection 203-3 of the specifications.

205-3.03 Embankment:

The placement and compaction of embankment shall conform with the requirements of Subsection 203-10 of the specifications.

205-3.04 Compacting and Finishing:

The top 6 inches of the subgrade shall be compacted to a density not less than 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer, except that when asphaltic concrete or Portland cement concrete is to be placed directly on subgrade, the required density shall be 100 percent.

The surface of the subgrade shall be finished to a reasonably smooth and uniform surface and in reasonably close conformity to the lines, grades, dimensions, and cross section shown on the project plans or established by the Engineer. The finished surface of the subgrade shall not vary by more than 0.04 feet above or below the grade established by the Engineer except when Portland cement concrete pavement or asphaltic concrete pavement are to be placed directly on the subgrade, the finished surface shall not vary by more than 0.02 feet above or 0.04 feet below the established grade.

205-4 Method of Measurement:

Measurement of grading roadway for pavement will be made by the square yard of the area prepared and subsequently covered with a subbase, base, asphaltic concrete, or Portland cement concrete; however, when raised median islands are constructed, the area occupied by these islands will be included in the area measured for payment. Where the new pavement is not bounded by curb and gutter and additional shoulder work is necessary to construct the typical section shown in the project plans, such work shall be considered as incidental and the cost will be considered as included in the cost of the contract bid item Grading Roadway for Pavement.

205-5 Basis of Payment:

The accepted quantities of grading roadway for pavement, measured as provided above, will be paid for at the contract unit price per square yard for the work, complete in place, as specified herein and as shown on the project plans.

SECTION 206 FURNISH WATER SUPPLY:

206-1 Description:

The work under this section shall consist of either developing or obtaining an adequate water supply and furnishing all water required for the work.

206-2 Blank:

206-3 Construction Requirements:

Material may be watered either at the source or on the roadway, at the option of the contractor.

If the contractor elects to apply water to materials at the source, and these materials will subsequently be measured and paid for on the basis of weight, the contractor shall give the Engineer ample notice of its intentions. Prior to the application of water, the contractor shall furnish such equipment and labor as may be necessary to enable the Engineer to obtain samples for determining the in-place moisture in the materials. The difference in weight between the average in-place moisture content of the material prior to pre-wetting and the average moisture content of the material at the time of weighing will be deducted from the total weight of the material.

206-4 Method of Measurement:

The work described in this section will be measured on a lump sum basis.

206-5 Basis of Payment:

Payment for this work will be made at the contract lump sum price.

No adjustment of compensation to the contract lump sum price for Furnish Water Supply will be made for any increase or decrease in the quantity of water required, regardless of the reason for such increase or decrease.

The cost of providing a water distribution system; the cost of delivering the water; and the cost of applying the water to aid the compaction of

the materials will not be paid for directly but will be considered as included in the prices paid for the various contract items requiring water.

When the bidding schedule does not contain a contract pay item for furnish water supply, full compensation for either developing or obtaining an adequate water supply and furnishing all water required for the work shall be considered as included in the prices paid for the various contract items of work requiring the use of water.

SECTION 207 DUST PALLIATIVE:

207-1 Description:

The work under this section shall consist of applying all water required for the control of dust as considered necessary for the safety and convenience of the traveling public, and for the reduction of the dust nuisance to adjacent property.

207-2 Blank:

207-3 Construction Requirements:

The use of pressure pumps and spray bars on all sprinkling equipment used for the application of dust palliative will be required. The use of gravity flow spray bars and splash plates will not be permitted.

Water applied for dust control shall be as approved or directed by the Engineer. The contractor shall provide appropriate equipment for effective control of dust.

207-4 Method of Measurement and Basis of Payment:

No measurement or payment will be made for application of dust palliative, including furnishing water and all necessary equipment and labor, the cost being considered as included in contract items.

SECTION 208 SEPARATION GEOTEXTILE FABRIC:

208-1 Description:

The work under this section shall consist of furnishing and placing a permeable separation geotextile fabric. The fabric shall be placed in accordance with the details shown on the project Plans and the requirements of these specifications.

208-2 Materials:

208-2.01 Geotextile Fabric:

The separation geotextile fabric shall be supplied in accordance with and conform to the material requirements of Subsections 1014-1 and 1014-4 of the specifications. Special attention shall be given to the required survivability of the fabric material which will be as called out in the Special Provisions or as shown on the plans.

208-2.02 Fabric Packaging, Handling, and Storage:

The identification, packaging, handling, and storage of the geotextile fabric shall be in accordance with ASTM D4873. Fabric rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Rolls will be stored on the site or at another identified storage location in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof, light colored, opaque cover. At no time, shall the fabric be exposed to sunlight for a period exceeding 14 days.

208-3 Construction Requirements:

208-3.01 Weather Limitations:

Separation geotextile fabric shall not be placed when weather conditions, in the opinion of the Engineer, are not suitable to allow placement or installation. This will normally be at times of wet or snowy conditions, heavy rainfall, extreme cold or frost conditions, or extreme heat.

208-3.02 Equipment:

Mechanical or manual laydown equipment shall be capable of handling full rolls of fabric, and laying the fabric smoothly, without wrinkles or folds. The equipment shall be in accordance with the fabric manufacturer's recommendations or as approved by the Engineer.

208-3.03 Surface Preparation:

The surface upon which the separation fabric will be placed shall be compacted and finished according to the requirements of these specifications.

208-3.04 Fabric Placement:

The separation geotextile fabric shall be unrolled on the finished surface and laid smooth without wrinkles. The placement of fabric by

dragging across the finished surface will not be allowed. The geotextile fabric shall be overlapped a minimum 24 inches for longitudinal and transverse joints. The center of a longitudinal overlapped joint shall be located in the same manner as a longitudinal pavement joint. Transverse overlaps shall be in the direction of aggregate placement.

208-3.05 Placement and Compaction of Aggregate:

Aggregate materials shall be placed by back dumping the aggregate in a manner which does not damage the fabric and then spreading the aggregate material onto the geotextile fabric in a constant forward direction. Traffic or construction equipment shall not be permitted directly on the geotextile unless approved by the Engineer for emergency purposes. Pins or piles of aggregate can be used to hold the geotextile in place while being covered.

Overstressing the subgrade soil shall be avoided by utilizing equipment in spreading and dumping that exerts only moderate pressures on the soil. If ruts of 2 inches or greater occur in the aggregate, the contractor shall use lighter equipment which transmits less ground pressure. Any ruts which develop during spreading or compacting aggregate shall be filled with additional aggregate rather than bladed from adjacent areas so that the final design aggregate thickness is maintained. Construction equipment shall not be allowed to turn or stop suddenly on the aggregate placed over the geotextile fabric.

Aggregate base shall be compacted as specified in Subsection 303-3.02 of the specifications. Aggregate base material shall not be mixed or processed on the separation geotextile fabric. The aggregate base material shall be premixed at the stockpile area or at another location in a manner approved by the Engineer. Aggregate base materials will be sampled for acceptance after premixing and prior to placement on the separation fabric. Contamination and segregation of aggregate base materials prior to or during placement shall be minimized.

Any damage to the fabric occurring during placement of the aggregate must be repaired immediately. The aggregate shall be removed from the damaged area to allow placement of a fabric patch extending three feet on all sides beyond the damaged area, followed by replacement of the aggregate.

208-4 Method of Measurement:

Separation geotextile fabric will be measured by the square yard in-place. Measurement will be to the nearest square yard. No allowance will be made for material in laps.

208-5 Basis of Payment:

The accepted quantity of separation geotextile fabric, measured as provided above, will be paid for at the contract unit price per square yard, which price shall be full compensation for furnishing all labor, materials, and equipment, and performing all operations in connection with placing the separation geotextile fabric as shown on the project plans. No payment will be made for separation geotextile fabric rejected, or patches which are necessary, due to either contamination or damage due to either the fault or negligence of the contractor.

SECTION 301 LIME TREATED SUBGRADE:

301-1 Description:

The work under this section shall consist of preparing roadbed for lime treatment, furnishing and applying lime, mixing lime, and water with in-place material, and spreading, compacting and curing the mixture to the lines, grades, and dimensions shown on the project plans and in accordance with the requirements of the specifications.

301-2 Materials:

301-2.01 Lime:

Lime shall be approved prior to its use in accordance with Materials Policy and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

Lime shall be either a commercial dry hydrated lime or a commercial granular or pelletized quicklime, conforming to the requirements of ASTM C977.

Hydrated lime shall contain not less than 85 percent calcium hydroxide, Ca(OH)2, as determined by ASTM C25.

Quicklime shall contain not less than 94 percent total available calcium oxide and magnesium oxide (CaO + MgO), and not less than 90 percent total available calcium oxide (CaO), as determined by ASTM C25.

Lime from more than one source or more than one type may be used on the same project, but the different limes shall not be mixed. The lime shall be protected from exposure to moisture until used and shall be sufficiently dry to flow freely when handled.

The type of lime shall be as specified in the Special Provisions.

301-2.02 Water:

Water used for mixing shall conform to the requirements of Subsection 1006-2.02 of the specifications.

301-2.03 Bituminous Material for Curing Seal:

Bituminous material for curing seal shall be Emulsified Asphalt, Grade SS-1 conforming to the requirements of Section 1005 of the specifications.

301-3 Construction Requirements:

301-3.01 Preparation of Roadbed:

In-place material to be lime treated shall be scarified and thoroughly broken up to the full roadway width. The material to be treated shall contain no rocks larger than 2-1/2 inches in any dimension. The depth to be scarified shall be such that when the lime, water, and in-place material is mixed and compacted, the treated subgrade will be in close conformity to the specified thickness.

If the mixing machine to be used requires that the material be windrowed, the windrows shall be of uniform cross section and limited to such size that all the material can be passed through the mixer at each operation. Otherwise the material shall be shaped to the required line, grade and cross-section before application of lime and mixing.

301-3.02 Application of Lime:

Lime shall be added to the material to be treated at a rate specified in the Special Provisions. The actual application rate shall not vary by more than 10 percent from the rate specified. The equipment used to distribute the lime shall be approved by the Engineer and it shall be capable of uniformly distributing the required amount of lime for the full width of the pass.

When hydrated lime is used, the required amount of lime may be applied in the form of a slurry.

Lime or lime treated material shall not be spread or mixed when the soil is frozen, when the air temperature is less than 40 degrees F in the shade, or when conditions indicate that the temperature may fall below 40 degrees F within 24 hours.

The area upon which lime may be spread ahead of the mixing operation shall be limited to that which the contractor may thoroughly mix by the end of the working day.

No traffic other than water trucks and the mixing equipment shall be allowed to pass over the spread lime until after completion of mixing.

301-3.03 Mixing:

Mixing shall be accomplished by a traveling pugmill or a single or multiple transverse shaft mixer and shall be approved by the Engineer. It shall be equipped with a system capable of introducing water at a controlled rate during mixing in order to produce a completed mixture with a uniform moisture content within 2 percentage points of the optimum moisture content of the material being treated. The optimum moisture content will be determined in accordance with the requirements

of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Mixing or re-mixing operations shall continue until the material is uniformly mixed, free of streaks or pockets of lime. The final mixture shall not contain more than 5 percent of untreated dirt clods larger than 1 inch in diameter.

After the initial mixing operation and before the lime treated material is compacted, a curing period of 24 to 48 hours will be required.

If quicklime is used for subgrade treatment, sufficient water shall be added prior to or during initial mixing to slake all of the quicklime.

301-3.04 Compaction and Finishing:

The treated mixture shall be spread and compacted to the required width, grade, and cross-section.

The thickness of a compacted layer shall not exceed 8 inches. Where the required thickness is more than 8 inches, the mixture shall be spread and compacted in two or more approximately equal lifts. The moisture content shall be maintained to achieve compaction. Unless specified otherwise, the lime treated material shall be compacted to a density of at least 100 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Initial compaction shall be by means of sheepsfoot or grid rollers. Final compaction shall be by means of steel wheel or pneumatic tired rollers. Areas inaccessible to rollers shall be compacted to the required density by other means satisfactory to the Engineer.

The lime treated subgrade shall be finished to a reasonably smooth and uniform surface and in reasonably close conformity to the lines, grades, dimensions, and cross-sections shown on the project plans or established by the Engineer. The surface of the treated subgrade shall not vary by more than 0.04 feet above or below the grade established by the Engineer.

Damage to the lime treated subgrade which occurs as a result of the contractor's construction activities shall be promptly repaired by the contractor at no additional cost to the Department, when so directed by the Engineer.

301-3.05 Curing:

The surface of each compacted layer of lime treated material shall be kept moist until covered by a subsequent layer of lime treated material, or until a bituminous curing seal is applied. The bituminous curing seal

shall be applied uniformly at an approximate rate of 0.15 gallons per square yard of surface, the exact rate to be determined by the Engineer in accordance with the requirements of Subsection 404-3.05 of the specifications. The curing seal shall be applied as soon as possible after the completion of final compaction and before the temperature falls below 35 degrees F.

No equipment or traffic will be permitted on lime treated subgrade for three days after curing seal is applied, unless otherwise permitted by the Engineer. Subsequent subbase, base, or pavement course shall be placed within 10 days after the curing seal is applied.

Any damage to the curing seal or lime treated subgrade shall be promptly repaired by the contractor at no additional cost to the Department and as directed by the Engineer, until a subsequent subbase, base, or pavement course is placed over the lime treated subgrade.

301-3.06 Safety Program:

The contractor shall provide to the Engineer for review a detailed safety program for the protection of the workers and public, covering precautions to be exercised and emergency treatment to be available on the project site. The program shall include protective equipment for eye, mouth, nose, and skin protection; and a first aid kit with an eyeball wash. Said protective equipment shall be available on the project site during spreading and mixing operations. This program shall be provided and agreed upon before the lime spreading begins. The contractor shall actively enforce the program for the protection of its work force and others in the construction area. Adequate care must be taken to avoid quicklime contact during spreading and slaking operations.

301-4 Method of Measurement:

Hydrated lime or quicklime will be measured by the ton in accordance with the requirements of Section 109 of the specifications.

Subgrade treatment will be measured by the square yard of subgrade treated. The area will be determined from horizontal measurements of the surface area treated, excluding any side slopes of the treated section.

301-5 Basis of Payment:

The accepted quantities of lime and subgrade treatment, measured as provided above, will be paid for at the contract unit prices per ton for hydrated lime or quicklime, and per square yard for subgrade treatment, complete in place.

Payment for lime will include furnishing and application of lime.

Payment for lime treated subgrade will also include furnishing and application of curing seal.

SECTION 302 CEMENT TREATED SUBGRADE:

302-1 Description:

The work under this section shall consist of preparing the roadbed for cement treatment; furnishing and applying cement; mixing cement and water with in-place material; and spreading, compacting, and curing the mixture to the lines, grades, and dimensions shown on the project plans and in accordance with the requirements of the specifications.

302-2 Materials:

302-2.01 In-place Material:

In-place material on the roadbed shall be the native material or embankment.

302-2.02 Hydraulic Cement and Water:

Hydraulic cement and water shall conform to the requirements of Subsection 1006-2 of the specifications.

302-2.03 Bituminous Material for Curing Seal:

Bituminous material for curing seal shall be Emulsified Asphalt, Grade SS-1 conforming to the requirements of Section 1005 of the specifications.

302-3 Construction Requirements:

302-3.01 Preparation of Roadbed:

In-place material which is to be cement treated shall be scarified and thoroughly broken up over the full roadway width. The material to be treated shall contain no rocks larger than 2-1/2 inches in any dimension. The depth to be scarified shall be such that when the cement, water, and in-place material is mixed and compacted, the treated subgrade will be in reasonably close conformity to the specified thickness.

If the mixing operation requires that the material be windrowed, the windrows shall be of uniform cross-section and limited to a size that will allow all the material to pass through the mixer in each operation. Otherwise the material shall be shaped to the required line, grade, and cross-section before application of cement and mixing.

302-3.02 Application of Cement:

Cement shall be added to the material to be treated at the rate specified in the Special Provisions. The actual application rate shall not vary by more than 10 percent from the rate specified. The equipment used to distribute the cement shall be as approved by the Engineer and it shall be capable of uniformly distributing the required amount of cement for the full width of the pass.

Cement or cement treated material shall not be spread or mixed when the soil is frozen, when the air temperature is less than 40 degrees F in the shade, or when conditions indicate that the temperature may fall below 40 degrees F within 24 hours.

The area upon which cement may be spread shall be limited to that which the contractor can thoroughly mix and compact by the end of one-half of a work shift.

No traffic other than water trucks and mixing equipment shall be allowed to pass over the spread cement until after completion of mixing.

302-3.03 Mixing:

Mixing shall be accomplished with a traveling pugmill or a single or multiple transverse shaft mixer as approved by the Engineer. Mixers shall be equipped with a system capable of introducing water at a controlled rate during mixing and be capable of producing a completed mixture with a uniform moisture content. The moisture content of the completed mixture shall be within 2 percentage points of the optimum moisture content of the material being treated as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

The in-place material and cement shall be mixed such that cement balls are prevented from forming when water is added. Mixing shall be continued until the mixture is uniform and at the required moisture content.

302-3.04 Compaction and Finishing:

The treated mixture shall be spread and compacted to the required width, grade, and cross section.

The thickness of a compacted layer shall not exceed 8 inches. Where the required thickness is more than 8 inches, the mixture shall be spread and compacted in two or more approximately equal lifts. The moisture content shall be maintained to achieve compaction. Unless specified otherwise, the cement treated material shall be compacted to a density of at least 100 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the

ADOT Materials Testing Manual, as directed and approved by the Engineer.

Initial compaction shall be accomplished with sheepsfoot or grid rollers. Final compaction shall be accomplished with steel-wheel or pneumatic-tired rollers. Areas inaccessible to rollers shall be compacted to the required density as approved by the Engineer.

The cement treated subgrade shall be finished to a reasonably smooth and uniform surface and in reasonably close conformity to the lines, grades, dimensions, and cross-sections shown on the project plans or established by the Engineer. The surface of the treated subgrade shall not vary by more than 0.04 feet above or below the grade established by the Engineer.

Damage to cement treated subgrade which occurs as a result of the contractor's construction activities shall be promptly repaired by the contractor at no additional cost to the Department, when so directed by the Engineer.

302-3.05 Operation Time Requirement:

Not more than two hours shall elapse between the time water is added to the subgrade and cement, and the time of completion of initial compaction prior to trimming. Not more than 2.5 hours shall elapse between the time water is added to the subgrade and cement and the time of completion of final compaction after trimming, unless otherwise approved by the Engineer.

302-3.06 Curing:

The surface of cement treated subgrade shall be kept moist until a curing seal is applied. Bituminous curing seal shall be applied uniformly at the rate of 0.15 gallons per square yard of surface. The curing seal shall be applied on the same day that final compaction is performed and as soon after the final compaction as is practicable.

Any damage to the curing seal or the cement treated subgrade shall be promptly repaired by the contractor, at no additional cost to the Department and as directed by the Engineer.

After the curing seal has been applied, the cement treated subgrade shall be kept free of heavy equipment and traffic for a period of at least three days. Light construction traffic will be allowed after the curing seal has been placed. Subsequent subbase, base, or pavement course shall be placed within 10 days after the curing seal is applied.

Any damage to the curing seal or cement treated subgrade shall be promptly repaired by the contractor at no additional cost to the Department and as directed by the Engineer, until a subsequent

subbase, base, or pavement course is placed over the cement treated subgrade.

When the project plans call for 4 inches or more of aggregate base over the cement treated subgrade, the aggregate base may be used as the curing seal in lieu of a bituminous curing seal. The aggregate base shall be kept moist for 72 hours. The section may be opened to traffic immediately after placement and compaction of the aggregate base.

302-4 Method of Measurement:

Cement for cement treated subgrade will be measured by the ton.

Cement treated subgrade will be measured by the square yard of subgrade treated. The area will be determined from horizontal measurements of the surface area treated, excluding any side slopes of the treated section.

302-5 Basis of Payment:

The accepted quantities of cement, measured as provided above, will be paid for at the contract unit price per ton of cement furnished and applied.

The accepted quantity of cement treated subgrade, measured as provided above, will be paid for at the contract unit price per square yard of subgrade treatment, complete in place, including furnishing and applying a bituminous curing seal when required.

SECTION 303 AGGREGATE SUBBASES AND AGGREGATE BASES:

303-1 Description:

The work under this section shall consist of furnishing, placing, and compacting aggregate subbases and aggregate bases in accordance with the details shown on the project plans and the requirements of these specifications.

Aggregate subbases and aggregate bases are designated as Class 1 through Class 6. The class of aggregate subbase and aggregate base will be shown on the project plans or specified in the Special Provisions.

303-2 Materials:

Aggregate for the various classes of aggregate subbases and aggregate bases shall consist of stone, gravel or other approved inert material of similar characteristics, and shall be clean and free from vegetable matter and other deleterious substances.

Aggregate subbase and aggregate base material may be comprised of processed salvaged asphaltic concrete, processed salvaged aggregate base material, processed salvaged Portland Cement Concrete materials, virgin aggregate base materials or any combination of these materials meeting the requirements of Table 303-1. These materials may be from a specific project site or approved commercial source. Processed salvaged materials shall conform to the requirements specified in AASHTO M 319.

Aggregate subbases and aggregate bases shall conform to the requirements of Table 303-1:

TABLE 303-1

Class of Agge-gate	Percent Passing Sieve (Inch or No.)									PI, Max.
	3	1-1/2	1	3/4	1/4	4	8	30	200	
1		100	90-100				35-55		0-8.0	3
2		100	90-100			38-65	25-60	10-40	3.0-12.0	3
3										
4	100				35-70				0-10.0	5
5	100				35-70				0-10.0	5
6										

Notes:

(1) The PI (Plasticity Index) will be determined in accordance with the requirements of AASHTO R 58, T 89, and T 90.

(2) Classes 1, 2 and 3 are bases; Classes 4, 5 and 6 are subbases.

(3) The requirements for Class 3 and for Class 6 will be specified in the Special Provisions.

(4) For Class 1 through Class 4 aggregate, the amount of one fractured face coarse aggregate particles shall be at least 50 percent.

(5) Resistance to abrasion for Class 1 through Class 4 aggregate will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of 12 percent at 100 revolutions

Maximum loss of 40 percent at 500 revolutions

(6) When determining gradation of aggregate subbase or aggregate base material containing processed salvaged asphaltic concrete materials, drying to a constant weight shall be performed at a temperature of 140 ± 5 degrees F, in accordance with the requirements of AASHTO T 265.

Aggregate subbase and aggregate base material not conforming to the requirements of Table 303-1 for gradation and/or PI may be accepted by the Engineer upon the contractor's submittal of testing results demonstrating that the R-Value is at least 79 when determined by AASHTO T 190. At the contractor's option, the material may be reprocessed and re-compacted at no additional cost to the Department.

All metal reinforcement and expansion materials shall be removed from processed salvaged Portland Cement Concrete prior to its use in aggregate subbase and aggregate base material.

The contractor shall submit the testing information for the base and subbase materials which are intended to be used to the Engineer for approval. Any significant change in the materials shall be approved by the Engineer prior to use.

Mixing on grade shall be accomplished using a full depth reclamation machine or pulverizer, manufactured for this purpose. Motor graders, gannon boxes, auger scrapers, or other similar devices will not be allowed for mechanical mixing on grade.

If suitable in-place aggregate subbase or aggregate base materials are available, the contractor shall have the option of re-using such materials as processed salvaged aggregate base. Processed salvaged asphaltic concrete and salvaged Portland Cement Concrete materials may be blended with the processed salvaged aggregate subbase, processed salvaged aggregate base and virgin base aggregates. The blended material shall be homogenous mixture in which there is no segregation, crusts, lumps, or nesting, and shall be sampled and tested to meet the requirements specified herein.

303-3 Construction Requirements:

303-3.01 Placement:

Aggregate subbases and aggregate bases shall have water added to them and shall be mixed and processed to produce a uniform blend of material before final placement. After processing, the material shall be placed and spread on the prepared subgrade, subbase or base in a uniform layer or layers not exceeding 6 inches in compacted depth, unless otherwise approved in writing by the Engineer. The method of dumping or spreading shall be determined by the contractor. The spread material shall be free of segregation.

When processed salvaged materials are utilized, either from in-place or from a commercial source, the Engineer may require a test section of 1000 feet be placed utilizing the processed materials and construction methods proposed for use by the contractor. Full operations shall not proceed until the test section has been tested and approved by the Engineer. The contractor shall use the same equipment, material processing, and construction methods for the remainder of the

construction, unless adjustments made by the contractor are approved in advance by the Engineer.

303-3.02 Compaction:

Each layer of aggregate subbase and aggregate base material shall be compacted to a density of not less than 100 percent of the maximum density determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

The moisture content shall be determined per AASHTO T 265 when determining density for aggregate subbase and aggregate base material containing processed salvaged asphaltic concrete and/or processed salvaged Portland Cement Concrete.

When AASHTO T 265 is utilized to determine moisture content, acceptance testing results for density will be furnished to the contractor up to 24 hours after performance of in-place density testing to allow sufficient time for moisture determination.

303-3.03 Finishing:

The final layer of subbase or base shall be finished with equipment capable of shaping and grading the finish surface within the tolerances specified herein.

The finished surface of aggregate subbase or aggregate base shall not vary from the grades established by the Engineer by more than ± 0.04 feet.

The compacted layers of aggregate subbase and aggregate base shall be maintained in a condition satisfactory to receive any subsequent subbase, base, or surfacing material or traffic, when so required.

Areas not within the allowable tolerance shall be corrected by scarifying, placing additional material, re-mixing, reshaping, and re-compacting to the specified density and surface tolerance.

303-3.04 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) when specified in the Special Provisions.

At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed:

(a) Aggregate production, including crusher methods, pit extraction, and washing.

(b) Stockpile management, including stacking methods, separation technique, stockpile pad thickness, and segregation prevention.

(c) Transporting and placing, including transport technique, lift thickness, processing and mixing technique, and compaction methods.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Aggregate Base Class 1, 2, or 3			
Fractured Coarse Aggregate Particles	AASHTO T 335	Crusher belt or Stockpile	1 per 1,200 CY
Gradation	AASHTO T 11 AASHTO T 27	Crusher belt or Stockpile	1 per 600 CY
PI	AASHTO T 89 AASHTO T 90	Crusher belt or Stockpile	1 per 600 CY
Proctor Density	AASHTO T 99	Crusher belt or Stockpile	1 per Source and as needed
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	Roadway	1 per 600 CY
Aggregate Subbase Class 4, 5, or 6			
Fractured Coarse Aggregate Particles	AASHTO T 335	Crusher belt or Stockpile	1 per 1,200 CY
Gradation	AASHTO T 11 AASHTO T 27	Crusher belt or Stockpile	1 per 600 CY
PI	AASHTO T 89 AASHTO T 90	Crusher belt or Stockpile	1 per 600 CY
Proctor Density	AASHTO T 99	Crusher belt or Stockpile	1 per Source and as needed
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	Roadway	1 per 600 CY

303-4 Method of Measurement:

The quantity of aggregate subbase and aggregate base will be calculated by the cubic yard in place, using plan dimensions.

303-5 Basis of Payment:

The accepted quantities of aggregate subbase and aggregate base, measured as provided above, will be paid for at the contract unit price per cubic yard, which price shall be full compensation for the work, complete in place.

SECTION 304 CEMENT TREATED BASE:

304-1 Description:

The work under this section shall consist of furnishing and mixing aggregate, cement, and water, and spreading, compacting, and curing the mixture in accordance with the details shown on the project plans and the requirements of these specifications.

304-2 Materials:

304-2.01 Aggregate:

Aggregate shall conform to the requirements of Subsection 303-2 of the specifications for Class 2 aggregate, unless otherwise specified in the Special Provisions.

304-2.02 Hydraulic Cement and Water:

Hydraulic cement and water shall conform to the requirements of Subsection 1006-2 of the specifications.

304-2.03 Bituminous Material for Curing Seal:

Bituminous material for curing seal shall be Emulsified Asphalt Grade SS-1 conforming to the requirements of Section 1005 of the specifications.

304-2.04 Mix Design:

The contractor shall determine the mix proportions and shall furnish cement treated base conforming to the requirements specified herein. The job-mix design with the supporting test results shall be submitted to the Engineer and the Engineer's approval shall be obtained prior to incorporating any of the material into the work. The brand of cement and the location of the aggregate source shall be included with the job mix design data. A new mix design shall be submitted for approval any time the contractor requests a change in materials or proportioning of the materials from that given in the approved mix designs.

Unless otherwise specified, cement treated base shall contain no less than 165 pounds of hydraulic cement per cubic yard, and it shall attain a minimum compressive strength of 500 pounds per square inch at seven days.

304-3 Construction Requirements:

304-3.01 Preparation of Subgrade:

Cement treated base shall be placed on a prepared subgrade which shall have been constructed in accordance with the surface finish and grade tolerance requirements specified for the subgrade material involved.

The subgrade shall be free of loose or extraneous material and maintained in an acceptable condition throughout the treatment operation. Any soft or yielding areas of the subgrade shall be corrected prior to placement of cement treated base.

304-3.02 Mixing:

(A) General Requirements:

Aggregate and cement for cement treated base shall be proportioned and mixed in a central mixing plant, unless otherwise specified. The plant shall be either the batch-mixing type using revolving blade or rotary drum mixers, or the continuous mixing type. The aggregate and cement may be proportioned either by weight or by volume.

Water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water required per batch or the rate of water flow required for continuous mixing. The time of the addition of water or the points at which it is introduced into the mixer shall be as approved by the Engineer.

The moisture content of the completed mixture shall be uniform and within 2 percentage points of the optimum at the point of delivery to the work. The optimum moisture content will be determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

The cement shall be added in such a manner that it is uniformly distributed throughout the aggregate during the mixing operation. There shall be safe, convenient facilities for sampling the cement in the supply line to the weigh hopper or pugmill.

The charge in the batch mixer or the rate of feed to the continuous mixer shall not exceed that which will permit complete mixing of all of the mix material.

(B) Batch Mixing:

The mixer shall be equipped with a sufficient number of paddles of a type and arrangement which will produce a uniformly mixed batch.

The mixer shall be equipped with an accurate timing device which will indicate by a definite audible or visual signal the expiration of the mixing period.

The time of mixing a batch shall begin after all ingredients are in the mixer and shall end when the mixer is half emptied. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregate of unchanging appearance is produced. The time of the mixing shall not be less than 30 seconds.

The batch-mixing plant shall be equipped with sampling facilities as approved by the Engineer. The sampling facilities shall allow for the easy and safe collection of representative samples of aggregate and cement treated base mixture.

(C) Continuous Mixing:

Aggregate shall be drawn from the storage facility by a feeder or feeders which will continuously supply the correct amount of aggregate in proportion to the cement.

A control system shall be provided that will automatically close down the plant when the material in any storage facility approaches the strike-off capacity of the feed gate. The plant will not be permitted to operate unless this automatic control system is in good working condition.

The feeder for the aggregate shall be mechanically or electrically driven.

Continuous mix plants shall be equipped with sampling facilities approved by the Engineer.

The sampling facilities shall allow for the easy and safe collection of representative samples of aggregate and cement treated base mixture.

The cement feeder and the aggregate feeders shall be equipped with devices by which the rate of feed can be accurately determined while the plant is in full operation.

(D) Spreading:

Mixed material shall be transported from the plant to the roadway in approved vehicles and spread on a moistened subgrade in a uniform layer for the full width of the base under construction. Mixed material may be placed in partial widths as approved by the Engineer. Spreading shall be accomplished with approved spreader boxes or finishing machines or motor graders. If the Engineer approves the use of one spreader operating alternately on two or more lanes, not more than 30 minutes shall elapse between the time of placing the material in adjacent lanes at any location. The material shall be spread full depth in one pass unless otherwise specified.

Cement treated base shall not be mixed or placed while the air temperature is below 40 degrees F in the shade or when conditions indicate that the temperature may fall below 40 degrees F within 24 hours. Cement treated base shall not be placed on frozen subgrade or mixed when the aggregate is frozen.

304-3.03 Compacting and Finishing:

Initial compaction shall begin immediately after spreading. Successive passes of compacting equipment shall overlap the previous adjacent pass by at least 25 percent of its width. Following initial compaction and before final compaction, the treated material shall be trimmed by blading with a motor grader or a planing machine to obtain surface in reasonably close conformity with the lines, grades, and cross-sections established or shown on the project plans.

Extreme care shall be exercised by the contractor during the trimming operation so that no more material than is necessary is disturbed and so that the trimming operation can be completed as quickly as possible. Trimmed material shall be wasted if so directed. Compaction shall proceed without interruption, except as stated above, to achieve at least 100 percent of maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

The finished surface of cement treated base shall be uniform and shall not deviate at any point more than 0.03 feet from the bottom of a 10-foot straightedge laid in any direction.

The surface of the finished cement treated base shall not vary more than 0.04 feet above or below the grade established by the Engineer.

The surface shall be kept moist at all times until the curing seal is applied.

304-3.04 Operation Time Requirement:

Not more than two hours shall elapse between the time water is added to the aggregate and cement, and the time of completion of initial compaction prior to trimming. Not more than 2.5 hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final compaction.

304-3.05 Construction Joints:

At the end of each day's work or when cement treated base operations are delayed or stopped for more than two hours, a construction joint shall be made in thoroughly compacted material. The joint shall be normal to the center line of the roadbed and have a vertical face. Additional mixture shall not be placed until the construction joint has been approved by the Engineer.

When partial-width construction of cement treated base is allowed and when the material has been finally compacted more than one hour, a longitudinal joint shall be constructed by cutting back into the previously placed material to a point where it meets the proper line and grade, and trimmed to a true vertical face which is free of any loose or shattered material. Trimmed material shall be disposed of.

The face of transverse and longitudinal construction joints shall be moistened prior to placement of the adjacent base material.

304-3.06 Curing Seal:

After final compaction, the cement treated base shall be covered with a bituminous curing seal, applied uniformly to the surface at an approximate rate of 0.15 gallons per square yard. The curing seal shall be applied on the same day that final compaction is performed and as soon after the compaction as is practicable.

After the curing seal has been applied, the cement treated base shall be kept free of traffic for a period of at least three days. Only light construction traffic will be allowed from the fourth through the seventh day after the curing seal has been placed. Subsequent subbase, base, or pavement course shall be placed within 10 days after the curing seal is applied.

Any damage to the curing seal or the cement treated base shall be promptly repaired by the contractor, at its expense and as directed by the Engineer.

When the project plans call for 4 or more inches of aggregate base over the cement treated base, the aggregate base may be used as the curing seal in lieu of a bituminous curing seal. The aggregate base shall be kept moist for 72 hours after placement. The section may be opened to traffic immediately after placement and compaction of the aggregate base.

304-3.07 Cement Treated Base Strength Tests:

Samples for strength tests will be taken at random for each lot of production. A lot shall be considered to be the production during one shift. Each lot shall be represented by five random samples, each sampled and tested in accordance with Arizona Test Method 241. The mean value of the sample strengths will be reported to the nearest pound per square inch.

304-4 Method of Measurement:

Cement treated base will be measured by the ton.

304-5 Basis of Payment:

The accepted quantities of cement treated base, measured as provided above, will be paid for at the contract unit price for the cement treated base mixture, complete in place, including bituminous curing seal when required, except that an adjustment will be made to the unit price paid for any lot represented by the mean value of the seven-day compressive strengths as shown in Table 304-1.

TABLE 304-1

Mean Compressive Strength (Pounds per square inch)	Unit Price Adjustment (dollars per ton)
500 or more	0
450 to 499	- 1.50
400 to 449	- 3.25
350 to 399	- 5.00
Less than 350 *	- 7.00

Note:

*Material represented by lots attaining seven-day compressive strengths with a mean value less than 350 pounds per square inch will be evaluated as to acceptance. The Engineer will determine if the material can be left in place. Cement-treated base allowed to remain in place will be subject to the unit price adjustment. Cement-treated base not allowed to remain in place shall be replaced at no additional cost to the Department.

SECTION 305 LEAN CONCRETE BASE:

305-1 Description:

The work under this section shall consist of furnishing all materials and constructing a lean concrete base in accordance with the details shown on the project plans and the requirements of these specifications.

Lean concrete base shall consist of a mixture of aggregate, hydraulic cement, water, and admixtures.

305-2 Materials:

305-2.01 Hydraulic Cement and Water:

Hydraulic cement and water shall conform to the requirements of Subsection 1006-2 of the specifications.

305-2.02 Aggregate:

At the option of the contractor, the aggregate for lean concrete base shall be either Class 2 aggregate base material conforming to the requirements of Subsection 303-2 of the specifications or a combination

of fine and coarse aggregate for Portland cement concrete conforming to the requirements of Subsection 1006-2.03 of the specifications.

When Class 2 aggregate base material is used, it shall have a minimum sand equivalent value of not less than 50 when tested in accordance with the requirements of AASHTO T 176, and the plasticity index requirements presented in Subsection 303-2 of the specifications will not apply.

When a combination of fine and coarse aggregate is used, the coarse aggregate shall be Standard Size Designation No. 57 conforming to the requirements of AASHTO M 43. Fine aggregate shall have a minimum sand equivalent of not less than 50 when tested in accordance with the requirements of AASHTO T 176.

305-2.03 Admixtures:

Admixtures shall conform to the requirements of Subsection 1006-2.04 of the specifications.

305-2.04 Curing Compound:

Curing compound shall be Type 2, Class A liquid membrane-forming compound conforming to the requirements of Subsection 1006-6.01(C) of the specifications.

305-3 Construction Requirements:

305-3.01 Preparation of Subgrade, Subbase, or Base:

Lean concrete base shall be placed on a prepared subgrade, subbase, or base which shall have been constructed in accordance with the surface finish and grade tolerance requirements specified for the material involved.

The subgrade, subbase, or base shall be free of loose or extraneous material, kept uniformly moist immediately prior to placement of lean concrete base and maintained in an acceptable condition throughout the placement operation. Any soft or yielding area of the subgrade shall be corrected prior to placement of lean concrete base.

305-3.02 Forming:

Lean concrete base shall be constructed with slip-form equipment. Forming shall conform to the requirements of Subsections 401-3.03(A), 401-3.03(B), and 401-3.03(C) of the specifications.

305-3.03 Proportioning:

(A) Mix Design:

The contractor shall determine the mix proportions and shall furnish lean concrete base which shall contain not less than 275 pounds of hydraulic cement per cubic yard, however, the amount of cement in the mix may be reduced when fly ash is added as hereinafter specified. The lean concrete base shall attain a minimum compressive strength of 500 pounds per square inch at seven days.

The contractor shall submit a complete solid-volume mix design to the Engineer for review prior to incorporating the proposed mix into the work. Mix designs submitted for review shall include the weights and volumes of all ingredients; the brand, type and source of hydraulic cement and admixtures; the aggregate base or the coarse aggregate size number designation; the source of aggregate; the specific gravities of all ingredients; and a code number to identify the mix design. The contractor may submit mix designs from previous or concurrent projects.

The contractor shall make no changes in the mix designs or code numbers without the review of the Engineer. A new mix design shall be submitted for the Engineer's review any time the contractor proposes a change in materials or material proportions.

The contractor shall prepare trial batches of lean concrete base for each mix design. The number of trial batches required will be established by the Engineer and the Engineer may waive the requirements for trial batches at any time. The contractor shall prepare trial batches using materials, mixing equipment, procedures and batch sizes which are the same as those to be used in the work.

The Engineer will take test samples from the trial batches. When test results indicate the proposed mix will not meet the specified compressive strength requirements, the contractor shall submit a new mix design for review.

In no case will the Engineer's review or test of a mix design relieve the contractor of the responsibility to provide lean concrete base with the specified properties or material contents.

(B) Cement, Water, and Aggregates:

Cement, water, and aggregate shall be proportioned in accordance with the requirements of Subsections 1006-4.02(A), (B) and (C) of the specifications.

(C) Admixtures:

Admixtures shall be proportioned in accordance with the requirements of Subsection 1006-4.02(D) of the specifications.

Air-entraining admixtures will be required for lean concrete base placed at elevations above 3,000 feet. The amount of entrained air in the lean concrete mixture shall not be less than 4 percent, nor more than 7

percent by volume. At elevations below 3,000 feet, air-entraining admixtures may be used at the option of the contractor; however, the amount of entrained air in the lean concrete mixture shall not exceed 7 percent by volume.

An approved water reducing admixture shall be used.

A fly ash admixture may be used at the option of the contractor only when Portland cement is used. A maximum of 20 percent, by weight, of the Portland cement may be replaced with fly ash. A minimum of 1.2 pounds of fly ash shall replace each pound of Portland cement.

305-3.04 Mixing:

Mixing shall be performed in accordance with the requirements of Subsection 1006-4.03 of the specifications.

305-3.05 Consistency:

The contractor shall furnish lean concrete base having a slump of 4.5 inches or less. Lean concrete base that fails to conform to this consistency requirement will be rejected. Tests for consistency will be performed in accordance with the requirements of AASHTO T 119.

305-3.06 Weather Limitations:

Lean concrete base shall be constructed in accordance with the weather limitations of Subsection 1006-5 of the specifications.

305-3.07 Joints:

There shall be no longitudinal or transverse weakened plane joints in lean concrete base. Transverse construction joints shall be constructed normal to center line of the pavement at the end of each day's production and during other work interruptions as directed by the Engineer. When Portland cement concrete pavement is to be placed over lean concrete base, longitudinal construction joints in the lean concrete base shall be at least 2 feet from any subsequent longitudinal joint in the Portland cement concrete pavement.

305-3.08 Placing and Finishing:

Lean concrete base shall be placed and finished in accordance with the applicable requirements of Subsection 401-3.04 of the specifications except that Subsection 401-3.04(F) of the specifications, is not applicable.

Lean concrete base may be placed either for the full width in a single pass or in two or more passes, provided that each pass is a minimum of 12 feet wide wherever possible. Longitudinal construction joints

between passes shall conform to the requirements of Subsection 305-3.07 of the specifications.

The surface of the lean concrete base shall be finished to a smooth floated surface and the surface plane shall not vary by more than 1/8 inch in any direction when measured with a 10-foot straightedge, nor vary by more than 1/4 inch across any construction joint.

305-3.09 Curing:

Curing of lean concrete base shall begin immediately after surface finishing operations. Liquid membrane-forming compound shall be applied to the surface and sides of the lean concrete base at a rate of not less than one gallon per 100 square feet.

The curing compound container shall be equipped with a calibrated sight glass for verification of quantities used.

305-3.10 Production Lot:

The compressive strength and thickness of lean concrete base will be evaluated for each lot of production. A lot shall consist of 4,000 square yards, or fraction thereof, of continuously placed lean concrete base, on a daily basis.

305-3.11 Compressive Strength:

The minimum average compressive strength of lean concrete base shall be 500 pounds per square inch for each lot at seven days. Each lot shall be represented by four random samples. A strength test will consist of the average strength of two cylinders prepared with material taken from a single load of lean concrete base. If any cylinder should show obvious evidence of improper sampling, molding, or testing, it will be discarded and the strength test will consist of the strength of the remaining cylinder. All test cylinders will be prepared in accordance with the requirements of AASHTO T 23. Testing for compressive strength will be performed in accordance with the requirements of Arizona Test Method 314. The mean value of the four compressive strength tests will be reported to the nearest pound per square inch. The unit price paid for the lean concrete base in that lot will be adjusted in accordance with the provisions of Subsection 305-5 of the specifications.

305-3.12 Opening to Traffic:

No traffic or equipment will be permitted on lean concrete base until the material has attained the specified seven-day compressive strength. However, when lean concrete base is to be placed adjacent to previously constructed lean concrete base, the paver and work bridges required for completing the new width will be permitted on the lean concrete base 72 hours after placement.

The contractor shall schedule its operations and route its equipment such that the base is subjected to minimal traffic. When it is necessary for construction traffic to travel on lean concrete base which has attained the specified compressive strength, the traffic shall comply with all legal load restrictions applicable to traffic on state highways. No overloaded vehicles will be permitted to travel on the lean concrete base under any circumstances.

Damage to the curing compound or to the lean concrete base which occurs as a result of the contractor's construction activities shall be promptly repaired by the contractor at no additional cost to the Department, when so directed by the Engineer.

305-3.13 Lean Concrete Base Thickness:

Lean concrete base shall be constructed to the specified thickness. Tolerances allowed for base and subgrade construction and other provisions of the Specifications which may affect thickness shall not be construed to modify the lean concrete base thickness requirements.

To determine thickness acceptability, the contractor shall drill 4 inch minimum diameter cores at the locations specified by the Engineer.

The Engineer will determine average core thickness in accordance with the provisions of AASHTO T 148, except that the measurements will be made to the nearest thousandth of an inch, and the average of the measurements will be reported to the nearest hundredth of an inch.

When calculating average core thicknesses, cores which exceed the specified thickness by more than 0.25 inches will be considered to have the specified thickness plus 0.25 inches.

The Engineer may make field thickness measurements in lieu of measurements in accordance with AASHTO T 148 when an initial core taken from any unit exceeds the specified thickness; however, when the initial core is less than the specified thickness or when there is any question as to the unit thickness, thicknesses will be determined in accordance with AASHTO T 148.

To determine the acceptability of each lot of lean concrete base, the following procedures will be followed:

(A) An initial core shall be drilled in each lot and, if the thickness of the core is not deficient by more than 0.25 inches, the thickness of the lean concrete base in that lot will be considered acceptable;

(B) If the thickness of the initial core is deficient by more than 0.25 inches, but less than or equal to 0.75 inches, two additional cores shall be drilled within that lot and the thickness of the three cores will be averaged. The average

of the three cores will be used to determine acceptability, and the unit price paid for the Lean Concrete Base in that lot will be adjusted as specified in Subsection 305-5 of the specifications; and

(C) If any core is deficient by more than 0.75 inches, additional cores shall be drilled at intervals not to exceed 10 feet in each direction from the deficient core, parallel to the roadway center line, until one core is obtained in each direction which is not deficient by more than 0.75 inches. The lean concrete base between these two cores will be evaluated separately from the balance of the lean concrete base in that lot, and unless otherwise directed by the Engineer, shall be removed and replaced with lean concrete base of the specified thickness.

At all locations where cores have been drilled, the resulting holes shall be filled with lean concrete base or other similar material as approved by the Engineer.

305-4 Method of Measurement:

Lean concrete base will be measured by the square yard.

305-5 Basis of Payment:

The accepted quantities of lean concrete base, measured as provided above, will be paid for at the contract unit price, complete in place, except that an adjustment to the nearest cent in the contract unit price will be made in accordance with Table 305-1 and Table 305-2, when either the quality of concrete represented by the mean value of the four compressive strength tests is less than the specified seven day compressive strength or when the average lengths of cores indicates deficiencies in thickness by more than 0.25 inches, but less than or equal to 0.75 inches.

Where a deficiency exists in both the average length of cores and the average compressive strength, the amount of the contract unit price allowed will be the appropriate percentage of contract unit price allowed from Table 305 1 less the unit price adjustment from Table 305 2.

TABLE 305-1
ADJUSTMENT IN CONTRACT UNIT PRICE FOR DEFICIENCY IN THICKNESS OF LEAN CONCRETE BASE

Average Core Length, Less Than Specified Thickness: Inches	Unit Price Allowed: Percent of Contract
0.00 to 0.25	100
0.26 to 0.35	93
0.36 to 0.45	85
0.46 to 0.55	75
0.56 to 0.75	50

Greater than 0.75*	25

Note:

*Material represented by cores deficient by more than 0.75 inches in thickness and/or represented by lots attaining seven-day compressive strengths with the mean value of the four compressive strength tests less than 350 pounds per square inch will be evaluated as to acceptance. The Engineer will determine if the material can be left in place. Lean concrete base allowed to remain in place will be subject to the unit price adjustments presented in Tables 305-1 and 305-2. Lean concrete base not permitted to remain in place shall be removed and replaced at no additional cost to the Department.

TABLE 305-2
ADJUSTMENT IN CONTRACT UNIT PRICE FOR DEFICIENCY IN COMPRESSIVE STRENGTH OF LEAN CONCRETE BASE

Mean Compressive Strength (pounds per square inch)	Unit Price Adjustment ** (dollars per square yard)
500 or more	0
450 to 499	- 1.50
400 to 449	- 3.25
350 to 399	- 5.00
Less than 350 *	- 7.00

Notes:

*Material represented by cores deficient by more than 0.75 inches in thickness and/or represented by lots attaining seven-day compressive strengths with the mean value of the four compressive strength tests less than 350 pounds per square inch will be evaluated as to acceptance. The Engineer will determine if the material can be left in place. Lean concrete base allowed to remain in place will be subject to the unit price adjustments presented in Tables 305-1 and 305-2. Lean concrete base not permitted to remain in place shall be removed and replaced at no additional cost to the Department.

**The Unit Price Adjustment will be multiplied by the design thickness of lean concrete base in inches, the product divided by 10, and rounded off to the nearest 25 cents to determine the unit price for payment.

SECTION 306 GEOGRID BASE REINFORCEMENT:

306-1 Description:

The work under this section shall consist of furnishing and placing a geogrid material within and/or below the aggregate base in accordance

with the requirements of the specifications and as shown on the project plans.

306-2 Materials:

306-2.01 Geogrid Materials:

The geogrid material shall be supplied in accordance with and conform to the material requirements of Subsections 1014-1 and 1014-3 of the specifications.

306-2.02 Geogrid Packaging, Handling, and Storage:

The identification, packaging, handling, and storage of the geogrid material shall be in accordance with ASTM D4873. Geogrid rolls shall be furnished with suitable wrapping for protection from the elements, primarily ultraviolet exposure, prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacturer, shipping date, and the project number and name to which it is assigned. Rolls will be stored on the site or at another identified storage location in a manner which protects them from the elements, and any other factor which may cause damage to the material. Care should be taken to prevent mud, wet cement, epoxy, and other contaminating materials which may permanently affix themselves to the grid material, from coming into contact with the geogrid. If stored outdoors, geogrid rolls shall be elevated and protected with a light colored, opaque, and waterproof cover. At no time shall the geogrid material be exposed to ultraviolet light for a period exceeding 14 days or stored in temperatures below 0 degrees F or in extreme heat. Torn, damaged, or defective geogrid will be rejected.

306-3 Construction Requirements:

306-3.01 Weather Limitations:

The geogrid shall not be placed when weather or surface conditions, in the opinion of the Engineer, are not suitable for placement. This will normally be at times of wet and snowy conditions, heavy rainfall, extreme cold or frost conditions, or extreme heat.

306-3.02 Equipment:

Mechanical or manual laydown equipment shall be capable of laying the geogrid properly and smoothly, according to the manufacturer's recommendations.

306-3.03 Surface Preparation:

If the geogrid material is to be placed directly on the subgrade, the subgrade surface shall be compacted and finished according to Subsections 203-3.03, 203-10.03, or 205-3.04 of the specifications prior to placement of the geogrid. If the geogrid material is to be placed within the aggregate base materials, the aggregate base surface upon which the geogrid will be placed, shall be compacted according to Subsection 303-3.02 of the specifications and finished according to Subsection 303-3.03 of the specifications before placement of the geogrid.

306-3.04 Geogrid Placement:

The geogrid shall be rolled out along the alignment in the direction of advancing construction. All wrinkles and folds shall be removed.

A 12-inch minimum overlap is required at all transverse and longitudinal joints.

The center of a longitudinal overlapped joint in a geogrid layer shall be staggered a minimum of 1 foot with relation to the center of a longitudinal overlapped joint in any immediate underlying geogrid layer.

The center of a longitudinal overlapped joint in a geogrid layer below an asphaltic concrete pavement shall be located within 1 foot of the center of a lane or within 1 foot of the centerline between two adjacent lanes.

At transverse joints, the top layer of the geogrid shall overlap the lower layer of geogrid in the direction that the aggregate base will be placed.

The geogrid shall be tensioned by hand and anchored to the ground with securing pins at the edges, including overlaps, and in the center of the roll at 30-foot intervals along the roll length, at the corners if applicable, or as directed by the Engineer. Securing pins shall be 3/16-inch diameter steel bars, with a minimum length of 4 inches, pointed at one end and fabricated with a head to retain a steel washer having an outside diameter of not less than 1.5 inches. Alternatively, U-shaped pins may be used if approved by the Engineer. The use of securing pins may be reduced or eliminated by the Engineer if it can be shown that by careful installation the geogrid is adequately tensioned by hand and anchored by the placed aggregate in a progressive installation process as recommended by the manufacturer's representative.

Care shall be taken to ensure that geogrid sections do not separate at overlaps during construction. Placement of geogrid around corners will require cutting of the geogrid product and diagonal overlapping of the same to make sure that excessive buckling of geogrid material does not occur.

306-3.05 Placing and Compacting Aggregate Fill:

The aggregate shall be back dumped and spread in a uniform lift maintaining the design aggregate thickness at all times. The aggregate material shall be bladed onto the geogrid in such a manner that the aggregate rolls onto the grid ahead, by gradually raising the dozer blade while moving ahead.

If the underlying material is capable of supporting rubber tire trucks (end and belly dumps) they may drive over the grid at very low speeds, less than five miles per hour, and dump aggregate as they go. Sudden stops and turning by trucks shall be avoided while on the grid. No tracked vehicles shall be allowed on the grid until there is a minimum of 6 inches of material between the tracks and the grid.

Any ruts which might develop during spreading or compacting the aggregate shall be filled with additional aggregate rather than bladed from surrounding areas. Placing additional aggregate into the rutted areas ensures that the design aggregate thickness is maintained.

Geogrid damaged after or during construction will be repaired in accordance with the manufacturer's recommended procedure.

Aggregate base shall be compacted as specified in Subsection 303-3.02 of the specifications. Aggregate base material shall not be mixed or processed on the geogrid. The aggregate base material shall be premixed at the stockpile area or another location in a manner approved by the Engineer. Aggregate base materials will be sampled for acceptance after premixing and prior to placement on the geogrid material. Contamination and segregation of aggregate base materials prior to or during placement shall be minimized.

306-4 Method of Measurement:

Geogrid base reinforcement will be measured by the square yard in-place. Measurement will be to the nearest square yard. No allowance will be made for material in laps.

306-5 Basis of Payment:

The accepted quantity of geogrid base reinforcement, measured as provided above, will be paid for at the contract unit price per square yard, which price shall be full compensation for furnishing all labor, material, and equipment, and performing all operations in connection with placing the geogrid. No payment will be made for geogrid base reinforcement which has been rejected.

SECTION 307 GEOCOMPOSITE EDGE DRAIN:

307-1 Description:

The work under this section shall consist of furnishing all labor, equipment, and materials to install a pavement edge drain system. The drainage system shall be installed in accordance with the specifications, plans, and manufacturer's recommendations. The purpose of the geocomposite edge drain is to provide drainage for the pavement base course while restricting loss of fines.

307-2 Materials:

307-2.01 Geocomposite Edge Drain:

The geocomposite edge drain material shall be supplied in accordance with and conform to the material requirements of Subsections 1014-1 and 1014-7 of the specifications.

307-2.02 Geocomposite Packaging, Handling, and Storage:

The identification, packaging, handling, and storage of the geocomposite edge drain material shall be in accordance with ASTM D4873. Geocomposite edge drain material shall be furnished in rolls, or in another acceptable manner wrapped with a suitable protective covering to protect the fabric from mud, dirt, dust, debris, or harmful ultraviolet light. The edge drain material shall be free of defects or flaws which significantly affect its physical properties at the time of delivery and installation. Each roll or package shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Geocomposite edge drain materials shall be stored on the site or at another location approved by the Engineer in a manner which protects them from the elements. If stored outdoors, the materials shall be elevated and protected with a light colored, opaque, and waterproof cover. At no time shall the edge drain material be exposed to direct sun light for a period exceeding 14 days.

307-3 Construction Requirements:

307-3.01 Weather Limitations:

The geocomposite edge drain shall not be placed when weather conditions, in the opinion of the Engineer, are not suitable to allow placement or installation. This will normally be at times of wet and snowy conditions, heavy rainfall, extreme cold and frost conditions, or extreme heat.

307-3.02 Equipment:

Trenching equipment shall be capable of excavating the necessary trenches for the edge drain and outlet pipes. Mechanical or manual equipment shall be capable of properly installing the edge drain and

lateral outlet pipes, and backfilling according to the specifications, plans, and manufacturer's recommendations.

307-3.03 General:

The contractor will not be allowed to begin installation of the edge drain system unless a representative of the edge drain manufacturer or supplier is present. The edge drain is to be placed in accordance with the manufacturer's recommendations in a trench having the dimensions as shown on the plans or as required by the manufacturer and approved by the Engineer.

307-3.04 Construction Method:

The trenches for the edge drain and necessary lateral outlet pipes shall be neatly cut through existing materials to the lines and dimensions shown on the plans or as recommended by the manufacturer and approved by the Engineer. The trenching method shall normally be by use of wheel cutter trenching equipment although an alternative method may be approved by the Engineer. The edge drain material including lateral outlet pipes, shall be placed in accordance with the plans and the manufacturer's recommendations. The edge drain shall be placed so that the fabric on one side is in intimate contact with the aggregate base materials. It may be necessary to use spacers or blocks to keep the edge drain up against the aggregate base during backfilling. The trench with the edge drain in place may be backfilled with minus-2-inch material that was excavated from the trench, provided that sharp rocks or other material which, in the opinion of the Engineer may damage the fabric, are removed.

The soil backfill shall be placed in lifts not to exceed 6 inches of compacted depth with the backfill compacted to a density not less than 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. Care shall be taken during compaction to prevent damage to the edge drain material or lateral pipes. The final 2 inches of the edge drain trench shall be filled with hot asphaltic concrete, meeting the material requirements of Section 409 of the specifications, and compacted. The amount of trench excavated at any time shall not exceed the amount of pavement edge drain system which can be installed and the backfill completed in one working day. Backfill must be placed to the top of the edge drain trench if the asphaltic concrete will not be placed in the same working day.

All necessary splices and connections are to be made with kits furnished by the manufacturer and in accordance with the manufacturer's specifications and directions.

307-3.05 Damage to Pavement:

The contractor shall not damage the adjacent existing pavement during the excavation and placement operation. Any damage done to the pavement shall be repaired, at no additional cost to the Department, in a method approved by the Engineer.

307-4 Method of Measurement:

Geocomposite edge drain will be measured by the linear foot in-place. Measurement will be to the nearest foot. No allowance will be made for laps or lateral pipes.

307-5 Basis of Payment:

The accepted quantity of geocomposite edge drain, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for furnishing all labor, material, and equipment and performing all operations in connection with installing the geocomposite edge drain as shown on the project plans. No payment will be made for geocomposite edge drain rejected due to either the fault or negligence of the contractor.

SECTION 401 PORTLAND CEMENT CONCRETE PAVEMENT:

401-1 Description:

The work under this section shall consist of furnishing all materials and constructing a pavement surface using Portland cement concrete and shall include coring operations, furnishing and placing dowels and tie bars, furnishing and placing miscellaneous reinforcing steel and joint materials, and constructing joints in accordance with the details shown on the plans and the requirements of the specifications.

The contractor shall proportion, mix, place, finish, and cure concrete in accordance with the requirements of the specifications.

401-2 Materials:

Portland cement concrete for pavement shall consist of a mixture of hydraulic cement, fine aggregate, coarse aggregate, water, and admixtures.

Unless otherwise provided, Portland cement concrete pavement shall conform to the requirements of Section 1006 of the specifications. Concrete shall be Class P.

Materials for expansion joint filler and joint seal shall conform to the requirements of Section 1011 of the specifications unless otherwise shown on the project plans or specified in the Special Provisions.

Materials for tie bars and dowel bars shall conform to the requirements of Section 1003 of the specifications. Materials for dowel bars shall conform to the requirements of AASHTO M 254 with Type B coating except that the core material shall conform to the requirements of ASTM A615, Grade 40. When epoxy coated reinforcing steel is designated, it shall conform to the requirements of Subsection 1003-5 of the specifications.

Liquid membrane curing compound shall conform to the requirements of Subsection 1006-6.01(C) of the specifications.

401-3 Construction Requirements:

401-3.01 General:

At least 20 days prior to paving, the contractor shall furnish the following information for the Engineer's review for specification compliance:

(A) A detailed sequence and schedule of concrete placement operations including, but not necessarily limited to; width of pavement to be placed, proposed equipment, production

rates, working hours, concrete hauling, placement methods, curing, sawing, and sealing methods;

(B) A detailed staking plan for subgrade controls including offset requirements; and

(C) A traffic control plan for pavement construction operations which includes provisions for the placement and maintenance of barriers required to protect the pavement from traffic for a minimum of seven days after concrete placement.

Mainline concrete pavement shall be constructed with slip-form paving equipment; however, areas inaccessible to slip-form paving equipment may be constructed with fixed side forms. Ramps and irregular pavement areas shall be constructed with either slip-form paving equipment or fixed side forms.

Unless otherwise shown on the plans, the main roadway, including concrete shoulders or distress lanes, shall be placed in a single monolithic pass, provided the finished surface of the pavement consistently conforms to the requirements for grade, alignment and pavement smoothness as specified herein. Paving widths which are less than the full main roadway width shall be constructed with longitudinal construction joints that are located on the lane line or at the edge of the main roadway.

The contractor may submit an alternate paving plan for review by the Engineer. The alternate plan shall be submitted in writing at least 45 days prior to paving and the Engineer's approval shall be obtained prior to proceeding with alternate paving methods.

Portland cement concrete pavement shall be constructed as required, smooth and true to the required lines, grades, and dimensions.

Use of 3-D Machine Control PCC Paving (wireless) shall require the contractor to submit the type of vertical and horizontal control (any combination of Global Positioning System (GPS), total stations, and/or laser), and the proposed equipment and daily calibration plan with the paving plan submittal. At least 10 days prior to paving, the contractor shall provide the Engineer with eight hours of formal training on the equipment proposed by the contractor to be utilized for 3-D Machine Control PCC paving.

401-3.02 Pavement Base:

The surface of lean concrete base, cement treated base, or subgrade upon which the concrete pavement is to be placed shall conform to the finish and elevation requirements specified for the material involved. The surface shall be free of all loose and extraneous material and the

surface shall be uniformly moistened immediately prior to placing concrete.

When Portland cement concrete pavement is constructed over lean concrete base, curing compound shall be applied to the surface of the lean concrete base at a rate of not less than 1 gallon per 150 square feet. The curing compound shall be Type 2 with a Class A vehicle conforming to the requirements of Subsection 1006-6.01(C) of the specifications and the nonvolatile portion of the Class A vehicle shall contain natural or petroleum waxes. This curing compound shall be placed in addition to curing compound placed as part of lean concrete base construction and shall be applied no more than 24 hours prior to placement of Portland cement concrete pavement. The curing compound shall be allowed to set-up prior to placement of Portland cement concrete pavement.

Curing compound may be applied after placement of required load transfer dowel assemblies; however, uniform coverage with curing compound must be achieved under the dowel assemblies and spot spraying or additional applications of curing compound may be required to achieve uniform coverage. If load transfer dowel assemblies are placed after application of curing compound, the curing compound shall be allowed to set-up prior to dowel placement. Curing compound membrane which is damaged during placement of load transfer dowel assemblies or during other operations shall be repaired with a reapplication of curing compound prior to placement of Portland cement concrete pavement.

Portland cement concrete pavement shall not be placed over lean concrete base or cement treated base for at least seven days after placement of the lean concrete base or cement treated base unless otherwise approved by the Engineer.

401-3.03 Forming:

(A) General:

Unless the project requires contractor surveying, the Engineer will place one stake for elevation control and alignment on each side of the roadway at 50-foot intervals and at grade breaks in accordance with the contractor's staking plan. The contractor shall make any additional projections necessary to establish line and grade.

If the project requires surveying by the contractor, the contractor shall place stakes for elevation control and alignment as specified above, or as approved by the Engineer.

If 3-D Machine Control PCC Paving (wireless) is utilized, the contractor shall stake for vertical and horizontal control on each side of the roadway at 50-foot intervals and at grade breaks, as specified elsewhere herein, for three days of production or a minimum distance of 2,500 feet,

whichever is greater, for verification. Once verification of 3-D Machine Control PCC Paving (wireless) has been accepted by the Engineer, staking for horizontal and vertical control shall identify all points of curve (P.C.), points of tangent (P.T.), and other alignment changes, and shall be at intervals of not less than 100 feet on curves and 200 feet on tangents, unless otherwise specified by the Engineer. In no case shall intervals exceed 1,000 feet.

(B) Slip-Form Method:

The contractor shall set taut guide lines to control both line and grade, or develop a 3-D slope model if 3-D Machine Control PCC Paving (wireless) is utilized.

Slip-form equipment shall be equipped with automatic sensing and control devices and shall operate such that the machine automatically follows the guide line (wire) or the 3-D slope model if 3-D Machine Control PCC Paving (wireless) is utilized. The contractor shall provide electronic data from the 3-D slope model in a format acceptable to the Engineer for approval 10 days prior to paving. The contractor shall check and recalibrate the 3-D Machine Control system every day that paving will be performed.

Slip-form paving equipment shall be equipped with traveling side forms designed to laterally support the concrete for a length of time which is sufficient to produce pavement of the required cross section.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation from the alignment shown on the plans shall not exceed 0.10 feet.

(C) Fixed Form-Manual Method:

Forms shall be set to the required lines and grades well in advance of placing concrete and shall be as approved by the Engineer prior to concrete placement.

Forms shall be made of steel and have an approved section with a base width of at least 4 inches and a depth equal to or greater than the thickness of the pavement. The forms shall be staked with steel stakes of appropriate lengths. Each form section shall have a stake pocket at each end and at intervals of not more than 5 feet. The stake pockets shall have a device for locking the form to the steel stakes. Each form section shall be straight and free of bends and warps at all times. The top of each form section shall not vary from a true plane by more than 1/8 inch in 10 feet and the inside face shall not vary more than 1/4 inch in 10 feet.

Wood or other rigid forms may be used in irregular areas as approved by the Engineer.

Forms shall be thoroughly cleaned and oiled each time they are used.

Before forms are placed, the underlying material shall be finished to the required grade and shall be firm and smooth. The forms shall be uniformly supported upon the subgrade or base and shall be placed to the required grade and alignment. Forms shall be supported so that they will not deviate more than 1/8 inch from the proper elevation during paving operations.

Forms shall remain in place until the day after placing the concrete and shall be removed in a manner that will prevent damage to the pavement. Pry bars shall not be used between the forms and the pavement under any circumstances.

401-3.04 Placing and Finishing:

(A) General:

When daytime ambient temperatures are expected to exceed 100 degrees F and when directed by the Engineer, concrete shall be placed only between the hours of 8:00 p.m. and 8:00 a.m.

Immediately prior to placing concrete, the contractor shall verify that the elevations of guide wires controlling slip-form pavers and the elevations of fixed forms are such that the thickness and finished grade of the pavement will be in accordance with the requirements of the project plans and these specifications.

Concrete shall be placed using methods that result in a minimum of handling and segregation and in a manner that will result in the concrete being distributed uniformly across the front of the paving machine.

Concrete placement shall be continuous between expansion or construction joints. The concrete shall be struck off, consolidated and floated by mechanical methods. The contractor may, with the approval of the Engineer, use a free floating, oscillating screed device, which is a minimum of 10 feet in length and attached to the paver, in conjunction with or in lieu of tubular floats. When pavement widths are less than 10 feet and where it is impractical to use mechanical methods, manual methods may be used to finish the concrete surface.

If surface drying or cracking should occur prior to the application of curing material, the entire surface of the concrete shall be kept damp by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The water from the nozzle shall not be applied directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

The contractor shall protect the base or subgrade when equipment is cleaned at the end of each days production. All concrete deposited on the base or subgrade during the cleaning operation shall be removed

from the base or subgrade immediately after cleaning is completed. Any damage to the base or subgrade, shall be repaired, as approved by the Engineer, prior to commencing paving operations. Water will not be permitted to pond on the roadway.

Any concrete which is spilled, splattered, or scattered on existing pavement shall be removed before the end of each day's paving operations.

It is important in the performance of the work and in the operation of equipment that no work shall lag and all operations shall be completed within the optimum or specified time; therefore, the Engineer may order the work suspended, if necessary, to maintain proper balance of operations so as to insure satisfactory results.

(B) Slip-Form Method:

The equipment shall spread, consolidate, screed, and float-finish the concrete so that a minimum of hand finishing will be necessary and a well consolidated and homogeneous pavement is produced. Additional labor and equipment shall be supplied when paving beyond the limits of the side forms is required.

The machine shall vibrate the concrete for the full width and depth of the concrete. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete and spaced not more than 24 inches center-to-center. Vibrators shall operate at a minimum of 8,000 impulses per minute. Concrete placement shall cease immediately if a vibrator fails to function and cannot be immediately repaired, replaced, or supplemented with additional vibrators.

The machine shall be operated with as nearly a continuous forward movement as possible and all mixing, delivering, and concrete spreading operations shall be coordinated to provide uniform progress. If for any reason it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped simultaneously.

Pavement edge slump in excess of 0.02 feet, exclusive of edge rounding, shall be corrected. If correction is not possible while the concrete is plastic, pavement with excessive edge slump shall be corrected by one of the following methods:

(1) The pavement shall be removed by saw-cutting a distance not greater than 1 foot from the pavement edge between adjacent transverse joints. Tie bars shall be placed as specified in Subsection 401-3.05 of the specifications and the pavement shall be replaced as part of adjacent Portland cement pavement construction; or

(2) If excessive edge slump can not be corrected by method one (1) above, then the pavement shall be removed for the full lane width between adjacent transverse joints and replaced as specified in Subsection 401-4.03(C) of the specifications.

When concrete is being placed adjacent to previously constructed pavement, work bridges for placing and finishing the pavement and the tracks on one side of the paver may be allowed on the new pavement provided that:

(1) The previously placed pavement has been placed for a minimum of 72 hours;

(2) Pressure exerted on the pavement by the paver shall not exceed 20 pounds per square inch;

(3) Tracks on the paver shall be equipped with protective pads, or the surface of the existing pavement shall be protected so that the surface is not damaged; and

(4) No part of the track shall be operated within 1 foot of the edge of the existing pavement.

Any pavement which is damaged by the contractor's equipment shall be repaired as approved by the Engineer and at no additional cost to the Department.

With the exception of saws used for the construction of weakened plane joints, no other contractor's equipment will be allowed on the pavement until all the requirements specified herein have been met.

(C) Fixed Form Method:

Three types of self-propelled mechanical equipment: the spreader, the finisher, and the float will be required; however, a single machine combining two or more of these operations may be used if it has been demonstrated that such a machine will accomplish satisfactory results. All wheels of all machines that ride on finished concrete surfaces shall be equipped with rubber tires.

The concrete shall be spread uniformly between the forms, immediately after it is placed, by means of the spreading machine. The spreader shall be followed by the finishing machine equipped with not less than two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine or to the finishing machine. Vibrators shall not rest on new pavements or side forms or contact any tie bars, and power to the vibrators shall be such that when

the motion of the machine is stopped, vibration will cease. Vibrators shall operate at a minimum of 8,000 impulses per minute.

The concrete shall be spread full width before being struck off by the finishing machine. The concrete shall be struck off and consolidated so that the surface will conform to the finished grade and cross section shown on the project plans and at the same time leave sufficient material for the floating operation. The spreading or finishing machine shall move over the pavement as many times and at such intervals as may be required to ensure thorough consolidation.

After the pavement has been struck off and consolidated, it shall be floated with an approved longitudinal float.

The contractor may use a longitudinal float composed of one or more cutting and smoothing floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more wheels riding on, and constantly in contact with, the forms.

The contractor may use a longitudinal float which is worked with a sawing motion while being held in a floating position parallel to the roadway centerline and while passing gradually from one side of the pavement to the other. Movements ahead along the centerline of the roadway shall be in successive advances of not more than one half the length of the float.

In lieu of using either type of longitudinal float, a single machine which will affect satisfactory consolidating, finishing and floating may be used. This machine may be towed by a spreading machine. This combination finishing-floating machine shall be equipped with screeds and vibrators as hereinbefore specified for finishing machines. Floating shall be accomplished with a non-oscillating float held in a suspended position from the frame.

If any spreading, finishing, and floating equipment is not maintained in full working order or if the equipment used by the contractor proves inadequate to obtain results prescribed, such equipment shall be improved or satisfactory equipment substituted or added.

(D) Fixed Form-Manual Methods:

Manual methods may be permitted by the Engineer in areas inaccessible to mechanical equipment.

When manual methods are permitted, concrete shall be deposited, spread, and struck off to such an elevation that, when properly consolidated, the surface will conform to the required lines and grades. The strike board shall be moved forward with a combined longitudinal and transverse motion so that neither end is raised from the side forms. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times.

The concrete shall be consolidated by internal vibration. Vibrators shall operate at a minimum of 8,000 impulses per minute. Use of vibrators for shifting of the concrete mass will not be permitted.

After consolidation, the concrete shall be tamped to the proper surface elevation and cross section with an approved tamping or screeding device or with a mechanical vibrating unit spanning the full width between forms. A small surplus of concrete shall be kept in front of the tamper or vibrating unit. Tamping or vibrating shall continue until the required cross section is obtained and the mortar is flushed slightly to the surface.

Other approved methods may be used to finish the concrete.

On grades in excess of 5 percent, a second strike board shall follow behind the tamper or vibrating unit and shall be used in the same manner as the tamper to remove waves caused by the flow of concrete.

(E) Joint Finishing and Edging:

The pavement edges and joints shall be edged in accordance with the details shown on the plans.

(F) Surface Texturing:

Surface texturing of the plastic concrete shall begin immediately after placement and finishing of the concrete. All excessive surface water shall be dispersed prior to commencing texturing operations. Texturing shall be performed by applying a longitudinal burlap drag followed by longitudinal texturing using steel tines. When the pavement will be overlaid with asphaltic concrete prior to opening to traffic, only a burlap drag is required.

Steel tines shall be supported by an independent self-propelled rolling mechanical bridge. The tines shall not be supported manually except in areas inaccessible to the bridge.

The rolling mechanical bridge supporting steel tines shall be equipped and operate with automatic sensing and control devices which follow the same control line as the slip form paver. Burlap shall not be supported on the rolling mechanical bridge used to support the steel tines.

Burlap shall be in accordance with AASHTO M 182, Class 3 and shall traverse the full width of the pavement to within 12 inches of the pavement edge.

The timing of the texturing operations is critical. Grooves that close following texturing will not be permitted, and texturing shall be completed so that the surface is not torn or unduly roughened by the texturing operation.

Hand tine brooms shall be provided and available at the job site at all times.

Tine texturing shall be performed so that the grooves produced will be uniform in spacing, depth, and width. Texture shall be parallel to the center line of the roadway and shall extend over the entire roadway width to within three inches of the pavement edge. Swerving groove patterns will not be permitted.

Texture grooves shall be 1/8 ± 1/32 inch in width and 5/32 ± 2/32 inch in depth. The textured groove depth will be measured in accordance with the requirements of Arizona Test Method 310. The center-to-center spacing of the grooves shall be 3/4 ± 1/8 inch.

If necessary, hardened concrete shall be textured by any method that will produce the required grooves.

(G) Curing:

Curing compound shall be applied to the concrete within 15 minutes after surface texturing operations and before any drying shrinkage or craze cracks begin to appear. In the event of surface drying or cracking, application of water with an atomizing nozzle shall be started immediately and shall be continued until application of curing material is begun or resumed; however, curing compound shall not be applied over any resulting free standing water.

Liquid curing compound shall be applied in one or more applications totaling not less than 1 gallon per 100 square feet. The curing compound container shall be equipped with a calibrated sight glass for verification of quantities used.

When the ambient temperature is above 85 degrees F, as verified by a Department-furnished calibrated thermometer, the contractor shall fog the surface of the concrete with an atomized mist of water. The surface of the pavement shall be kept moist until initial joint sawing is completed; fogging done after curing material has been applied shall not begin until the curing compound has set sufficiently to prevent displacement.

When misting is required, the entire surface of the concrete shall be kept damp by applying water with a nozzle that atomizes the flow so that a mist and not a spray are formed. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Concrete curing shall be continued for not less than seven days and any damaged curing material shall be repaired immediately.

401-3.05 Joints:

(A) General Requirements:

Joints in concrete pavement will be designated as transverse expansion joints; longitudinal or transverse construction joints; or longitudinal or transverse weakened plane joints.

The faces of all joints shall be constructed perpendicular to the surface of the concrete pavement.

Joints shall be constructed of the type, to the dimensions, and at the locations shown on the plans and as specified herein.

Concrete placed in lanes adjacent to previously placed concrete shall have transverse weakened plane joints located to align with the weakened plane joints in the previously placed concrete.

(B) Longitudinal Joints:

Longitudinal joints in the main roadway shall be weakened plane joints or construction joints. Weakened plane joints shall be constructed by sawing.

Longitudinal weakened plane joints shall be constructed between traffic lanes and also between traffic lanes and shoulders if concrete shoulders wider than five feet are specified.

Longitudinal joints in ramps and tapers shall be either weakened plane joints or construction joints. The location of longitudinal joints in ramps and tapers shall be as approved by the Engineer.

Load transfer bars shall be provided as shown on the plans, and shall be placed in all longitudinal construction and weakened plane joints by acceptable mechanical methods, either while the concrete is still plastic or after the concrete has hardened. Bars placed in hardened concrete shall be anchored with an adhesive approved by the Engineer. Bars placed in adjacent slabs of different thicknesses shall be placed within 1 inch of the mid-depth of the thinner slab.

(C) Transverse Joints:

Transverse expansion joints shall be located at the junction of roadway pavement slabs and bridge approach slabs. Transverse expansion joints at locations other than bridge approaches shall be located as shown on the plans. The joints shall be formed in accordance with the plans, or as directed by the Engineer.

Transverse construction joints shall be constructed as shown on the plans and as specified herein. They shall be placed at the end of each

day's production, or when placement of concrete is discontinued for more than 90 minutes. Excess concrete shall not be placed beyond a construction joint at the end of a day's production.

Load transfer bars shall be provided as shown on the plans, and shall be placed in all transverse construction joints by acceptable mechanical methods, either while the concrete is still plastic or after the concrete has hardened. Bars placed in hardened concrete shall be anchored with an adhesive approved by the Engineer. Bars placed in adjacent slabs of different thicknesses shall be placed within 1 inch of the mid-depth of the thinner slab.

Transverse construction joints shall be formed perpendicular or skewed to the center line of the roadway, as shown on the plans.

Transverse weakened plane joints shall be formed by sawing and shall be constructed perpendicular or skewed to the centerline of the roadway, as shown on the plans.

The location of transverse weakened plane joints shall be as shown on the plans. The spacing of the last four transverse weakened plane joints for each day's production may be adjusted by ± 1 foot.

401-3.06 Joint Construction:

(A) Sawed Joints:

Longitudinal or transverse weakened plane joints shall be sawed to the dimensions shown on the plans. Excess water from the sawing operation will not be permitted to stand on any subgrade to be paved. The contractor shall provide and maintain acceptable methods to control the water used in the sawing so the subgrade is not damaged.

Sawed joints shall be constructed before uncontrolled pavement cracking occurs; however, joints shall not be sawed until the concrete has hardened enough to prevent excessive tearing or raveling during sawing operations. The exact time when sawing will be done shall be determined by the contractor.

The contractor shall maintain an additional concrete span saw on the project site at all times during which sawed joints are being constructed. The additional saw shall be maintained in good operating condition and shall be readily available as a substitute for the primary concrete saw.

Any procedure used to saw joints which results in premature uncontrolled cracking shall be revised immediately. The contractor shall repair damaged areas or random cracks as specified and as directed by the Engineer.

If joints are sawed in stages, the initial saw cut shall be of the minimum specified width and shall be sawed to the depth shown on the plans.

Suitable guide lines or other devices shall be used to assure that joints are constructed at the locations shown on the plans.

After sawing, the joints shall be sealed in accordance with the following:

(1) Prior to applying the sealant, each joint face shall be thoroughly cleaned. The method of cleaning may be subject to regulation by state or local environmental quality enforcement agencies. When not otherwise mandated by law or regulation, the contractor shall clean the joints by sand blasting. The joints shall then be further cleaned by use of high-pressure air jets so that each face is clean, dry, and dust free. The air used in cleaning shall be free of oil and water;

(2) Asphalt-rubber joint sealant conforming to Subsection 1011-3 of the specifications shall be used when Portland cement concrete pavement is overlaid with an asphaltic concrete (asphalt-rubber) friction course. Silicone joint sealant conforming to the requirements of Subsection 1011-8 of the specifications shall be used when Portland cement concrete pavement is not overlaid with an asphaltic concrete (asphalt-rubber) friction course. Both types of sealant shall be applied in accordance with the manufacturer's recommendations;

(3) All recommended manufacturer's field testing shall be done by the Engineer. Necessary repairs resulting from field testing shall be immediately repaired by the contractor at no additional cost to the Department. Any sealant spilled on the concrete pavement shall be removed; and

(4) Immediately prior to applying silicone joint sealant, an expanded closed cell polyethylene foam backer rod, approved by the Engineer shall be inserted along the joint as shown on the plans. The backer rod shall be compatible with the joint sealant to be applied, and its diameter shall be at least 25 percent larger than the nominal width of the sawed joint.

Joints shall be sealed within 10 working days after the concrete has been placed and prior to opening the pavement to any traffic.

(B) Construction Joints:

Longitudinal and transverse construction joints shall be formed in accordance with the details shown on the plans or as directed by the Engineer.

When concrete is not finished, textured, and protected with curing material within one hour after placement, the Engineer may order the contractor to construct a transverse construction joint by sawing at the location established by the Engineer. All concrete placed beyond the construction joint shall be removed and disposed of by the contractor, at no additional cost to the Department, prior to continuing paving operations.

(C) Transverse Expansion Joints:

Transverse expansion joints shall be formed in accordance with the details shown on the project plans or as directed by the Engineer.

401-3.07 Opening Pavement to Traffic:

Pavement shall not be opened to traffic less than seven days after placement, and until all joints are sealed and the concrete has attained a compressive strength of at least 3,000 pounds per square inch, unless otherwise approved by the Engineer.

401-4 Pavement Evaluation and Remedial Measures:

401-4.01 Pavement Surface Texture:

The depth of surface texture grooves will be measured in accordance with the requirements of Arizona Test Method 310.

401-4.02 Pavement Smoothness:

(A) Testing Equipment:

Pavement smoothness will be evaluated by using Inertial Profiling System (IPS) equipment and will be tested in accordance with the requirements of Arizona Test Method 829b.

(B) Testing Procedure:

IPS measurements will be obtained upon opening of all travel lanes in their final configuration or as approved by the Engineer. Smoothness evaluations will be made in accordance with the International Roughness Index (IRI) and the results will be calculated by the Mean Roughness Index (MRI) for each segment tested.

The IPS measurements will be taken in each mainline traffic lane, cross street through lane, shoulders and each ramp lane.

The IPS measurements will begin 50 feet prior to the concrete placed during any day's production. The IPS measurements will include bridge approaches and 50 feet of any pavement which abuts the new pavement, without crossing the bridge deck joint.

The contractor shall broom the pavement or clean the pavement by other approved methods immediately prior to IPS measurements.

All mainline traffic lanes, ramp lanes, and cross street through lanes shall have an MRI <90 inches per mile in any 0.1-mile section.

All shoulders shall have an IRI<90 inches per mile in any 0.1-mile section.

(C) Grinding Equipment:

Pavement profile repairs shall be completed by grinding and shall be done with diamond blades, mounted on a self-propelled machine that has been designed for diamond grinding and texture of pavements. The grinding equipment shall weigh a minimum of 20,000 pounds including the grinding head, and be of a size that will grind a strip at least 3 feet wide. The effective wheel base of the machine shall be no less than 12 feet. The effective wheel base is defined as the distance from the front wheel assembly transverse pivot point to the transverse pivot point of the profile/depth control/ground drive wheels. The equipment shall have a positive means of vacuuming the grinding residue from the pavement surface, thereby leaving the surface in a clean, near-dry condition. Grinding equipment that causes raveling, aggregate fractures, spalls, or disturbances of the transverse and/or longitudinal joints shall not be used.

All grinding machines used in the cross-section of a lane shall have the same wheel base and grinding head configuration. To provide the proper surface finish and to achieve the designated texture on the pavement section, the contractor shall select the number of blades per foot ranging from 55 to 60 for the grinding process. A 1 to 2 inch overlap of grinding passes shall be allowed.

(D) Grinding Procedure:

All pavement profile repairs shall be made prior to pavement thickness evaluations. The contractor shall grind pavement areas with vertical deviations greater than 0.3 inches in 25 feet or less. After corrections, the affected 0.1-mile pavement section will be reevaluated.

Evaluations of pavement depressions will be made based on the presumed correction of adjacent high areas. When the pavement contains depressions greater than 0.3 inches in 25 feet or less, the contractor shall grind adjacent pavement as directed by the Engineer and the pavement will be reevaluated as specified above.

When the pavement contains depressions greater than 0.5 inches in 25 feet or less, the pavement shall be repaired as directed by the Engineer. Such repairs may include additional grinding or full-depth pavement replacement. Upon completion of repairs, the pavement will be reevaluated as required.

If, after the repair of high and/or depressed areas, the pavement does not conform to the specified profile requirements, additional pavement grinding and profile measurements shall be performed as directed by the Engineer.

(E) Surface Tolerance:

In addition to the MRI requirements, at the discretion of the Engineer, any pavement surface included in the bid quantity may be tested with a 10-foot straightedge. The surface shall not vary in any direction by more than 1/4 inch, including across any longitudinal or transverse construction joint. Grinding shall be required to ensure that this requirement is satisfied.

401-4.03 Pavement Cracks:

(A) General:

Cracks penetrating the full depth of the pavement shall be repaired or the cracked pavement shall be removed and replaced, as specified herein, prior to opening the pavement to public traffic.

Within 28 days after concrete placement and prior to acceptance of the work, the Engineer will perform a pavement crack survey. The pavement shall be cleaned prior to the crack survey.

Cracks which are visible without magnification and which require repair and pavement slabs which require replacement will be marked by the Engineer and shall be repaired or replaced by the contractor as specified, and at no additional cost to the Department.

Cracks observed later than 28 days after concrete placement and prior to final acceptance of the work shall be repaired by the contractor as specified and the cost of such repairs will be shared equally by the contractor and the Department.

The contractor shall provide the Engineer with detailed information concerning the methods and materials to be used for crack repair and the contractor shall obtain the Engineer's approval of the proposed methods and materials prior to beginning the required repairs.

The contractor, at its option and at no additional cost to the Department, may core cracked pavement, as approved by the Engineer, to determine the extent of cracking.

(B) Crack Repair:

(1) General:

Random cracks shall be repaired using the methods and under the conditions specified herein.

Crack repair shall begin within seven days after completion of the pavement crack survey and shall be completed within 30 days after the start of repairs.

Payment for pavement slabs which require repairs will be adjusted as specified in Subsection 401-6 of the specifications.

(2) Crack Repair Requirements:

(a) Cracks in Jointed Pavement Constructed with Load-Transfer Dowel Assemblies:

Longitudinal cracks which occur more than 54 inches from a longitudinal joint or less than 12 inches from a longitudinal joint shall be repaired by the routing-and-sealing method.

Transverse cracks shall be repaired by the epoxy-injection method after any immediately adjacent uncracked joints are deepened to 1/2 inch above the dowels.

(b) Cracks in Jointed Pavement Constructed without Load-Transfer Dowel Assemblies:

Longitudinal cracks which occur more than 54 inches from a longitudinal joint or less than 12 inches from a longitudinal joint shall be repaired by the routing-and-sealing method.

When a transverse crack crosses or terminates in a transverse contraction joint, the uncracked portion of the joint shall be filled with an approved gray colored epoxy and the crack shall be repaired by the routing-and-sealing method.

When a transverse crack approximately parallels and is within 5 feet of an uncracked contraction joint, the uncracked joint shall be cleaned and filled with an approved gray colored epoxy and the crack shall be repaired by the routing-and-sealing method.

When a transverse crack is more than 5 feet from a transverse joint, either cracked or uncracked, the joint shall be resawed and resealed as originally specified, and the crack shall be repaired by the routing-and-sealing method.

(c) Cracks Occurring within Wheel Path:

Cracks occurring within the wheel paths, which are exclusive of the areas defined under Subsections 401-4.03(B)(2)(a) and 401-4.03(B)(2)(b), shall be considered unrepairable and the pavement shall

be removed and replaced in accordance with the requirements of Subsection 401-4.03(C) of the specifications.

(3) Crack Repair Methods:

(a) Routing-and-Sealing Method:

When the routing-and-sealing crack repair method is specified, the top of the crack shall be routed, with a routing machine approved by the Engineer, to a depth of at least 3/4 inch and to a width not less than 3/8 inch or more than 5/8 inch. The routing machine shall be capable of closely following the path of the crack and of widening the top of the crack to the required section without spalling or otherwise damaging the concrete. Loose and fractured concrete shall be removed and the routed crack shall be thoroughly cleaned and then sealed with an approved gray colored silicon sealant.

(b) Epoxy-Injection Method:

When the epoxy-injection crack repair method is specified, the crack shall be pressure injected with an approved gray colored epoxy.

Pressure injection of epoxy shall be done only between the hours of 11:00 p.m. and 7:00 a.m.

(C) Pavement Removal and Replacement:

Portland cement concrete pavement, having cracks not repairable in accordance with Subsection 401-4.03(B) of the specifications, shall be removed and replaced as directed by the Engineer.

Cracked pavement shall be removed and replaced to the limits established by the Engineer and will generally require removal of the full lane width of the slab over a length of at least 6 feet.

Pavement slabs containing a single diagonal crack intersecting the transverse and longitudinal joints within 1/3 of the width and length of the slab from the corner shall be repaired by removing and replacing the smaller portion of the slab as directed by the Engineer.

Pavement slabs containing multiple cracks through the full depth of the slab, separating the slab into three or more parts, shall be entirely removed and replaced as directed by the Engineer.

Excessively cracked pavement shall be removed and replaced over the full pavement width, as directed by the Engineer.

Pavement to be removed shall be cut full-depth prior to removal. In order to minimize over-cutting, 4-inch diameter full-depth cores shall be

drilled at the corners of the pavement to be removed as directed by the Engineer.

Base material which is damaged as a result of pavement removal shall be repaired or replaced by the contractor as approved by the Engineer.

Removed pavement and base material shall be disposed of by the contractor, as approved by the Engineer.

After removal of cracked pavement, dowel bars shall be placed by drilling and anchoring, using an approved epoxy, at approximately mid-depth in the existing concrete pavement. Dowel bars placed in longitudinal construction joints shall be 24 inches long, epoxy-coated, 5/8-inch diameter smooth dowels spaced at 30 inches, center-to-center. Dowel bars placed in transverse construction joints shall be 24 inches long, epoxy-coated, 1-1/2 inch diameter smooth dowels spaced at 12 inches, center-to-center. Dowel bars shall be placed in construction joints which coincide with existing transverse weakened plane joints. These dowel bars shall be 24 inches long, epoxy-coated, 1-1/2 inch diameter smooth dowels placed at distances of 6, 24, 42, 90, 117, and 135 inches from the adjacent longitudinal joint which is nearest to the outside shoulder.

Replacement concrete shall be placed, finished and cured in accordance with the requirements specified for the original pavement.

401-4.04 Pavement Thickness:

Concrete pavement shall be constructed to the specified thickness. Tolerances allowed for base and subgrade construction and other provisions of the specifications which may affect thickness shall not be construed to modify such thickness requirements.

Pavement will be evaluated for thickness by the lot. A thickness lot shall not contain more than one thickness depth and will normally be one full shift's production. For partial shifts, more than one shift may be included in a thickness lot. In addition, when more than one thickness depth is placed in the same shift, each individual thickness depth placed in that shift may be combined with portions of other shifts that have the same thickness depth to form a thickness lot. When a thickness lot includes more than one shift's production, it shall not exceed 5,000 square yards unless otherwise approved by the Engineer. The contractor shall submit a thickness lot layout plan to the Engineer for approval prior to paving.

The contractor shall obtain ten cores per lot, in accordance with AASHTO T 24, under the observation of an ADOT representative, and at randomly selected locations designated by the Engineer. However, the Engineer may exclude certain locations from random sampling should the Engineer determine that the location of the work precludes normal construction operations. The ADOT representative shall take immediate

custody of the cores. All cores will be measured by the Department in accordance with the provisions of AASHTO T 148, except that individual measurements on each core will be determined to the nearest thousandth of an inch, and the average of such measurements will be determined to the nearest hundredth of an inch. If any core indicates a deficiency of 0.60 inches or more from the specified thickness, that core shall not be used for determining the thickness property of the lot, and additional cores shall be drilled at intervals not exceeding 10 feet in each direction from the deficient core location, measured parallel to the center line, until one core is obtained in each direction which is not deficient by 0.60 inches or more. Pavement between these two cores shall be considered as rejected. The average of the measurements of the two cores will replace the measurement of the original deficient core in determining the thickness property of the lot.

At all locations where cores have been drilled, the resulting holes shall be filled with concrete as approved by the Engineer and at no additional cost to the Department.

401-5 Method of Measurement:

Portland cement concrete pavement will be measured by the square yard, calculated from the dimensions shown on the plans and adjusted by the amount of any change ordered by the Engineer. Any opening in excess of 1 square yard will not be measured for payment. No allowance will be made for pavement placed in excess of the specified dimensions.

401-6 Basis of Payment:

The accepted quantities of Portland cement concrete pavement, measured as provided above, will be paid for at the contract unit price adjusted as hereinafter provided, and will include full payment for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the pavement complete in place as shown on the plans and specified herein. When load transfer dowel assemblies are specified, separate payment for this work will be as specified in the Special Provisions.

No separate payment will be made for joints, the cost being considered as included in the contract item for Portland cement concrete pavement.

Remedial work required to correct pavement smoothness deficiencies shall be performed by the contractor at no additional expense to the Department.

The contractor shall provide for the maintenance and protection of traffic during pavement profile repairs and subsequent pavement profile measurements as directed by the Engineer and at no additional expense to the Department.

Cracked pavement slabs which require repair in accordance with the provisions of Subsection 401-4.03(B) of the specifications will be paid for at 80 percent of the contract unit price for the pavement repaired, as measured between the original longitudinal and transverse pavement joints abutting the repaired pavement; however, no adjustment to the contract unit price will be made for pavement slabs which contain only cracks which are observed later than 28 days after concrete placement. Unit price adjustments for cracked pavement slabs which require repair will be made independently of all unit price adjustments made for compressive strength, pavement thickness, and pavement smoothness.

Payment for thickness and compressive strength will be by the lot. Lot limits for thickness are described in Subsection 401-4.04 of the specifications. Lot limits for compressive strength are described in Subsection 1006-7.04(B) of the specifications. For each lot, pay factors will be determined for increasing or decreasing the unit price of the lot or rejection of the lot. The "Percent of Lot Within Limits (PWL)" for thickness and compressive strength shall be determined in accordance with the requirements of Subsection 109.11 of the specifications. Pay factors for thickness and compressive strength will be determined by entering Table 401-1 with PWL.

TABLE 401-1

Pay Factors for Thickness and Compressive Strength

PWL	Pay Factor (Dollars/Square Yard)
100	+1.00
95-99	+0.75
90-94	+0.50
85-89	0.00
80-84	-0.25
75-79	-0.75
70-74	-1.75
65-69	-3.25
60-64	-5.00
Below 60	Reject

Pay Factors for thickness and compressive strength will be determined and applied separately. A total Pay Factor will be determined for each lot by summing the individual pay factors for thickness and compressive strength. Any lot with a total Pay Factor less than minus $5.00 will be rejected. Any lot with a PWL below 60 for either thickness or compressive strength will be rejected.

PCCP smoothness pay adjustment will only be made on mainline traffic lanes and will be adjusted in accordance with PCCP Smoothness Pay Adjustment Table 401-2 specified herein.

TABLE 401-2

PCCP Smoothness Pay Adjustment

AS (inches/mile)	Pay Adjustment ($/0.1 mile)
<70	(70 - AS) x 70
≥70 and ≤80	0
>80 and <90	(80 - AS) x 80
≥90	Correction Required (1)

Notes:

(1) Any 0.1 lane-mile increment having an AS value equal to or greater than 90 shall be repaired by the contractor at no additional expense to the Department.

The total adjustment in payment to the contractor will be the summation of the individual adjustments for the respective 0.1 lane-mile increments, except the maximum total adjustment in payment allowed will be $9,000 per tested lane-mile.

Unit price adjustments for pavement smoothness will not be made for pavement in shoulders, ramps, tapers, cross roads, or frontage roads.

Unit price adjustments for pavement smoothness will be made independently of all unit price adjustments made for pavement thickness, compressive strength, and cracked pavement slabs which require repair.

Pavement rejected in accordance with this Section or Section 1006 of the specifications shall be removed and replaced with pavement meeting the requirements of both sections. However, within ten days of notification of rejected pavement, the contractor may submit a written proposal to accept the pavement at a reduced unit price. When the contractor has elected to rely on the results of core testing for compressive strength, the ten days will commence upon notification of the results of core testing. Such proposal shall contain an engineering analysis of the anticipated performance of the pavement if allowed to remain in place. The reduction in unit price shall reflect the commensurate reduction in life expectancy, but in no case shall it be less than the total of the negative pay factors involved. Within five working days after receiving the contractor's proposal, the Engineer will determine whether or not to accept it and will so notify the contractor. If the proposal is not accepted, the pavement shall be removed and replaced as hereinbefore specified. If the proposal is accepted, the Engineer will specify the conditions of acceptance.

SECTION 402 PORTLAND CEMENT CONCRETE PAVEMENT REPAIRS:

402-1 Description:

The work under this section shall consist of furnishing all materials and equipment necessary to repair Portland cement concrete pavement in accordance with the details shown on the plans and the requirements of the specifications.

The type of Portland cement concrete pavement repair may consist of one or a combination of the following:

(A) Partial Depth Repairs
(B) Full Depth Slab Repairs
(C) Diamond Grinding
(D) Pavement Grooving
(E) Joint and Crack Sealing
(F) Edge Sealing

402-2 Partial Depth Repairs:

402-2.01 Description:

The work shall consist of removing loose material and temporary bituminous patch material from potholes, damaged joints, and spalled areas, thoroughly cleaning and drying the repair area, and placing new repair material in reasonably close conformity with the existing pavement cross section.

402-2.02 Materials:

The contractor shall select one or more of the following products, or approved equal, as approved by the Engineer.

1. FPT Fibrecrete with primer
2. Crafco Techcrete with primer
3. Roklin Flexset
4. D.S. Brown Delpatch
5. R.J. Watson Poly-Tron

402-2.03 Construction Requirements:

Partial depth repair areas will be designated by the Engineer. If diamond grinding or pavement grooving is included as part of the project, the partial depth repair shall be performed prior to the commencement of the diamond grinding or pavement grooving work. The extent of the repair area will be marked by the Engineer and will be evaluated on an individual basis. The Engineer will be the final authority if questions arise in regard to the need for repair or the extent of a required repair.

The contractor shall furnish the Engineer with a copy of the product's technical data sheets with printed instructions for mixing and application, and the expiration date of the manufacturer's shelf life warranty. Material that has exceeded the shelf life warranty shall not be used. In order to assure proper mixing and placement, a qualified manufacturer's representative for the approved product shall be present at the start of partial depth repair operations, and shall remain until the Engineer is satisfied that the contractor is conforming to the recommended procedures.

Partial depth repair material shall not be placed under adverse conditions as detailed in the manufacturer's installation instructions

Handheld pneumatic tools shall be used to remove deteriorated material until sound clean concrete is exposed. If the depth of the partial depth repair area exceeds one-third the thickness of the concrete pavement slab, the affected portion of the pavement slab shall be removed and replaced in accordance with the requirements of Subsection 402-3 of the specifications.

Before application of the repair material, the exposed surfaces of the concrete shall be free of loose particles, oil, dust, traces of asphaltic concrete, other contaminants, and shall be cleaned in accordance with the manufacturer's recommendations. If the surface of the repair area is wet, the contractor shall dry the wet area using an open flame blow torch. Repair material shall be confined to the limits of the repair area and shall not overlap onto the surrounding pavement.

Repairs on both sides across a longitudinal or transverse joint shall be sawcut on the existing joint to structurally separate the two sides. The Engineer may approve the use of flexible repair materials, with modulus of elasticity less than 10 ksi, on both sides of a joint without a sawcut.

The repair area shall be finished to the cross-section of the existing pavement and textured with placement of broadcast sand prior to setting of the repair material. The repair area surface shall be struck off flush with the existing pavement surface.

Partial depth repairs shall be verified before substantial completion for acceptance. Repairs that have failed as determined by the Engineer shall be removed at no additional cost to the department and replaced with partial depth repairs meeting the requirements of these specifications.

402-2.04 Method of Measurement:

Partial depth repairs will be measured by the square foot. Each repair will be measured to the nearest one tenth square foot. The total cumulative measurement of all repairs will be rounded to the nearest square foot.

402-2.05 Basis of Payment:

The accepted quantities of partial depth repairs, measured as provided above, will be paid for at the contract unit price per square foot, which price shall be full compensation for the work, complete in place, including removal and disposal of the old pavement; and replacement of shoulder material which is removed or damaged during repair work.

402-3 Full Depth Slab Repairs:

402-3.01 Description:

The work shall consist of furnishing all materials and removing existing concrete pavement and constructing full depth repairs or full panel replacements of Portland cement concrete pavement at the locations shown on the plans or determined by the Engineer, as specified herein, and in reasonably close conformity with the existing pavement cross-sections.

402-3.02 Materials:

The contractor shall not place concrete material until the mix design has been approved.

Materials for Portland cement concrete shall conform to the requirements of Section 1006 of the specifications. Concrete shall be Class S, with size 57 coarse aggregate as designated in AASHTO M 43.

Materials furnished for joint seal shall conform to the requirements of Subsection 1011-3 of the specifications.

Materials furnished for tie bars shall conform to the requirements of Section 1003 of the specifications.

Materials furnished for dowel bars shall conform to the requirements of AASHTO M 254 with Type B coating except that the core material shall conform to the requirements of ASTM A615, Grade 60.

Liquid membrane forming curing compound shall conform to the requirements of Subsection 1006-6.01(C) of the specifications.

402-3.03 Construction Requirements:

Areas to be replaced will be as shown on the plans and/or as designated by the Engineer. If diamond grinding or pavement grooving is included as part of the project, the full depth repair shall be performed prior to the diamond grinding or pavement grooving work.

Pavement slabs containing two or more cracks through the full depth of the slab shall be repaired as a full depth slab repair.

The repair area shall be rectangular in shape, shall extend to include the full width of the existing panel, and shall be a minimum of six feet in length. Repair limits shall be such that any remaining section of the panel has a minimum length of six feet. Transverse joints shall align with existing joints unless otherwise indicated herein. When a repair area extends to an existing transverse joint with dowel bars, the repair limits shall be extended into the adjacent panel to a point just beyond the existing dowel bars. If this results in a panel length greater than 15 feet, an intermediate transverse joint shall be created. Repair areas shall be saw cut through the full depth of the concrete repair area.

The PCCP panel shall be removed by utilizing a lift out method. Any damage to the existing PCCP that is to remain, due to contractor's operations, shall be repaired at no additional cost to the Department. After removal of the PCCP panel, the contractor shall remove and clean any loose material. The contractor shall also re-grade and re-compact the base material prior to the placement of Portland cement concrete. Any damage resulting from panel removal or grade preparation, as determined by the Engineer, will be repaired at the expense of the contractor.

All transverse joints shall be constructed with plain round dowel bars. Dowel bars shall be 18" in length and shall be placed at 1.0 foot intervals, mid-depth of the panel. Dowels shall be placed parallel to the longitudinal joint and the roadway profile. Dowel bars shall not be placed within 1.0 foot of either edge of the panel (i.e. longitudinal joint). The dowel bar diameter shall be based on the pavement thickness as shown in the following table.

Pavement Thickness (inches)	Dowell Diameter (inches)
8.0 or less	1.0
8.5 or greater	1.25

The panel thickness for full depth repairs shall match existing.

When a repair panel has a different thickness than the adjacent panel, the dowel bar diameter and placement depth shall be determined based on the thinner panel.

Dowel bar holes shall be drilled with a mechanically supported drill to maintain proper alignment. Hole diameter shall be 1/8 inch larger than the dowel bar. Dowel bars shall be anchored into the existing concrete with an approved high viscosity epoxy. An epoxy retention disk shall be used to prevent anchoring material from flowing out of the hole. The retention disk shall fit snuggly over the dowel and against the face of the panel. Before concrete placement for the full depth repair, the 9-inch long free end of the dowel bar shall be uniformly coated with a thin film of heavy waterproof grease.

When the contiguous length of a repair is less than or equal to two full panels, or when a transverse joint does not align with the joints in an

adjacent panel, a 1/8 inch thick bond breaker shall be placed along the length of the longitudinal joints to isolate the full depth repair. The fiberboard shall be configured to fit snugly against the adjacent slab, for the full depth and length of the longitudinal face of the repair.

Longitudinal tie bars shall be installed when the length of a repair exceeds two consecutive panels. Tie bars shall be installed in accordance with Section 401 of the specifications, with the exception that they shall be No. 5 deformed bars.

The slab replacement shall be finished to the cross section of the existing pavement and textured with a stiff bristled brush to match the existing pavement. The replaced surface shall be flush with the existing pavement surface. Texturing will not be required if grinding or grooving shall be performed following the repair.

A new sealant reservoir shall be sawed or formed at the interface of the replacement and existing concrete, as well as any intermediate transverse joints. The full depth slab repair shall not be opened to traffic until all joints are sealed and the concrete has attained a compressive strength of at least 3000 pounds per square inch, unless otherwise approved by the Engineer.

402-3.04 Method of Measurement:

Full depth slab repairs will be measured by the square yard of pavement repaired. Each replacement will be measured to the nearest one tenth square foot. The total cumulative measurement of all pavement repaired will be rounded to the nearest square yard.

402-3.05 Basis of Payment:

The accepted quantities of full depth slab repairs, measured as provided above, will be paid for at the contract unit price per square yard, which price shall be full compensation for the work complete in place, including the saw cutting of joints and dowel and tie bars, dowel and tie bar installation, the removal and disposal of existing materials, the excavation and subsequent backfilling or repairs to base materials incidental to the removals and regrading and recompacting of the base material.

402-4 Diamond Grinding:

402-4.01 Description:

The work shall consist of diamond grinding the surface of existing concrete pavement to improve the ride characteristics, texture, and frictional properties of the roadway surface. Diamond grinding shall be performed at the locations shown on the plans and in accordance with the requirements of these specifications.

402-4.02 Construction Requirements:

(A) General:

Prior to diamond grinding, the contractor shall submit a plan on how to complete the diamond grinding work to the Engineer for review and approval. The plan shall include at a minimum a description of the diamond grinding method, a diamond grinding sequence plan, a list of required equipment types and quantities, truck ingress and egress, traffic control, concrete slurry collection and disposal, striping, and cleaning of the roadway before opening to traffic. Unless otherwise directed by the Engineer, or specified herein, the contractor shall design traffic control and provide ways to maintain it such that there shall be no stripe obliteration on the newly ground roadway surface.

The contractor shall determine the proper sequence of operations to comply with the requirements specified herein. If multiple passes of the diamond grinding equipment are required, the area will only be considered for payment once. A minimum of 95 percent of any 100- foot section of pavement surface shall be textured. Existing depressed pavement areas due to subsidence or other localized causes will be exempted from texture and smoothness requirements.

The contractor shall protect all bridge deck joints and any other roadway features that may be damaged by diamond grinding operations. If there are any existing damages to the joints, the contractor shall bring it to the Engineer's attention prior to the diamond grinding operation.

Prior to diamond grinding, all repairs shall be completed as shown on the plans and specified herein.

No equipment will be allowed within three feet of a traffic lane that is open to the public.

When applicable, prior to the commencement of the work, the diamond grinding of ramp tie-in locations, radiused geometry at interchanges, etc. may be adjusted for the purposes of finished configuration, measurement, and payment with the approval of the Engineer.

(B) Equipment:

Diamond grinding shall be done with diamond blades, mounted on a self-propelled machine that has been designed for diamond grinding and texturing of pavements. The grinding equipment shall weigh a minimum of 35,000 pounds including the grinding head, and be of a size that will grind a strip at least 3-feet wide. The effective wheelbase of the machine shall be no less than 12 feet. The effective wheelbase is defined as the distance from the front wheel assembly transverse pivot point to the transverse pivot point of the profile/depth control/ ground drive wheels. The equipment shall have a positive means of vacuuming the grinding residue from the pavement surface, thereby leaving the surface in a

clean, near-dry condition. Diamond grinding equipment that causes raveling, aggregate fractures, spalls, or disturbances of the transverse and/or longitudinal joints shall not be used.

All diamond grinding machines used in the cross-section of a lane shall have the same wheelbase and diamond grinding head configuration. To provide the proper surface finish and to achieve the designated texture on the pavement section, the contractor shall select the number of blades per foot ranging from 55 to 60 for the diamond grinding process. A 1 to 2 inch overlap of diamond grinding passes shall be allowed.

(C) Procedure:

The contractor shall diamond grind the roadway sections shown on the plans.

Pavement surfaces shall be ground longitudinally beginning and ending at lines perpendicular to the roadway centerline. All diamond grinding shall be done in a direction parallel to the pavement lane lines. Diamond grinding shall continue for the full lane width until the pavement surface on both sides of all transverse joints and all cracks are in the same plane. Longitudinal ridges in adjacent passes of the diamond grinding equipment shall not exceed 1/8 inch in depth. The diamond grinding shall produce a neat, uniform finished surface. Joints and crack faults shall be ground so that there is no more than a 1/16-inch differential between adjacent sides of the joints and cracks. Transitions between ground and unground areas of concrete at the boundaries shall be smoothly feathered in. The joints between lanes and project limits shall be feathered in such a way to not create a drop off between the adjacent pavement surface and new diamond ground surfaces. The contractor shall maintain the existing cross slope and provide for positive drainage. The finished cross slope shall mirror the pre-grind cross slope and shall have no depressions or misalignment of slope greater than ¼-inch per 10 feet when measured with a 10-foot straightedge. Shoulder or ramp lane diamond grinding shall transition from the mainline to provide positive drainage leaving no more than a 3/16-inch ridge and a smooth riding surface. If requested by the contractor and approved by the Engineer, smaller equipment may be used for diamond grinding shoulder transitions.

Transitions from PCCP to asphaltic concrete shall be located as shown on the plans.

The contractor shall diamond grind a test section of pavement, where designated by the Engineer, to determine that the equipment proposed for use on the project will provide the specified surface texture.

The diamond grinding process shall produce a pavement surface that is true in grade and uniform in appearance with longitudinal line-type texture. The line-type texture shall contain corrugations parallel to the pavement lane lines and present a narrow ridge corduroy type

appearance. The peaks of the ridges shall be 1/8-inch +/- 1/16-inch higher than the bottom of the grooves with evenly spaced ridges.

Diamond grinding shall result in at least 95% of any selected 2-foot by 100-foot longitudinal area meeting the specified surface texture.

The contractor shall be responsible for collection and disposal of all diamond grinding slurry. All slurry shall be vacuumed into a storage tank or truck and disposed of properly. The slurry from diamond grinding operations shall not be permitted to flow across lanes occupied by traffic, onto roadway shoulders or areas containing vegetation, or to flow into gutters or other drainage facilities. The slurry shall be removed prior to opening the ground pavement section to traffic.

(D) Surfacing and Quality Testing Requirements:

After the diamond grinding and joint and crack sealing have been completed and the roadway is ready for testing, the contractor shall submit a written notice to the Engineer indicating that the work has been completed and the roadway is ready for testing.

The final ground concrete pavement surface shall be evaluated for smoothness by testing with an inertial profiler. The roadway smoothness shall be tested in accordance with the requirements of Arizona Test Method 829. The contractor shall sweep and clean the roadway prior to testing.

Traffic control costs during the smoothness testing period will be reimbursed under the provisions of Section 701 of the specifications. Any additional traffic control costs incurred, due to corrective action work and subsequent pavement smoothness measurements shall be borne solely by the contractor.

Testing shall be performed within 2 weeks of the completion of diamond grinding. The Engineer will notify the contractor of the test results no later than 10 days after the testing has been performed.

Testing will be performed on mainline traffic lanes, and will include the full length of the diamond grinding segments under the contract. Unless otherwise specified in the contract documents, testing of distress lanes, shoulders, ramps, tapers, cross roads, and frontage roads will not be performed.

(1) Incentive/Disincentive:

A pay adjustment incentive/disincentive will be applied based on an Actual Smoothness Value (AS) for the mainline lanes and freeway to freeway ramps shown on the plans. IRI values will be measured in accordance with Arizona Test Method 829 and reported every 0.1 mile. The incentive/disincentive pay will be adjusted for every 0.1 mile and shall be determined in accordance with the following table:

PCCP Smoothness Pay Adjustment	
AS (inches/mile)	**Pay Adjustment $ / 0.1 mile**
<40	(45 – AS) x 45
≥40 and ≤50	0
>50 and <85	(45 – AS) x 45
≥85	Correction Required (1)

NOTES:

(1) Any 0.1 lane-mile increment having an AS value equal to or greater than 85 shall be repaired by the contractor at no additional expense to the Department.

The total adjustment in payment to the contractor shall be the summation of the individual adjustments for the respective 0.1 lane-mile increments, except the maximum total incentive allowed shall be $9,000 per tested lane-mile.

If repairs are required, the contractor shall prepare a written proposal detailing corrective actions and submit the proposal to the Engineer within 10 working days after the contractor's receipt of test results. Within three working days, the Engineer will review the submitted proposal and either accept it, or reject it and ask for a new proposal. If rejected, the contractor shall, within 10 working days, prepare and submit a new proposal for corrective action, based on discussions with the Engineer. The Engineer will review, and either accept or reject, the new proposal within three working days of receipt.

Upon completion of any necessary repairs, the 0.1 lane-mile increments containing repaired areas will be re-tested in accordance with the provisions of Arizona Test Method 829. Resultant values from re-testing will be used in determining the adjustment in payment to the contractor.

402-4.03 Method of Measurement:

Measurement for diamond grinding for payment will not be required unless adjustments are made in accordance with subsection 402-4.02(A) of this specification. When adjustments are required, diamond grinding will be measured by the square yard of ground pavement section. The ground section will be measured to the nearest 0.1 square yard. The total cumulative ground area measured will be rounded up to the nearest square yard.

402-4.04 Basis of Payment:

The accepted quantities of pavement diamond grinding, as shown in the bidding schedule and any adjustments as specified in subsection 402-4.02(A) of this specification, will be paid for at the contract unit price per square yard, which price shall be full compensation for the work, complete in place, as specified herein.

No measurement or payment will be made for feathering, the cost being considered as included in the contract item.

No measurement or payment will be made for water used during the diamond grinding process or the disposal of the diamond grinding slurry, the cost being considered as included in the contract item.

402-5 Pavement Grooving:

402-5.01 Description:

The work consists of furnishing all materials and grooving the surface of existing Portland Cement Concrete Pavement at the locations shown on the project plans and in accordance with the requirements of these specifications.

402-5.02 Blank:

402-5.03 Construction Requirements:

(A) General:

The pavement surface shall be grooved longitudinally.

The methods used and tolerances employed shall provide a surface which will provide good wet or dry driving characteristics.

Longitudinally grooved areas shall begin and end at lines normal to the pavement center line and shall be centered within the lane width.

No equipment shall be allowed within three feet of a traffic lane open to the public. Maintenance and Protection of Traffic shall be in accordance with Section 701 of the specifications.

Removal of all slurry or residue resulting from the grooving operation shall be continuous. Residue from grooving operations shall not be permitted to flow across shoulders or lanes occupied by public traffic or to flow into gutters or other drainage facilities. Dried residue, resulting from grooving operations, shall be removed from pavement surfaces with a pick up or power broom before such residue is blown by the action of traffic or wind.

The noise level created by machinery shall not exceed 86 dbA at a distance of 50 feet normal to the direction of traffic.

(B) Equipment and Procedures:

Longitudinal grooving shall be performed using multiple diamond blades mounted on a self-propelled machine designed for diamond grooving concrete pavement and bridge decks. The grooving equipment shall

have a depth control device enabling adjustment of the cutting head height to maintain the specified groove depth. The grooving equipment shall have the capability to maintain alignment to the center of the roadway. The equipment will be capable of installing grooves to the dimensions and spacing requirements specified herein.

At the beginning of each work shift, all grooving equipment shall be equipped with a full complement of grooving blades that are capable of cutting grooves of the specified width, depth and spacing.

If during the course of work, a single grooving blade on an individual grooving equipment becomes incapable of cutting a groove, work will be permitted to continue for the remainder of the work shift and the contractor will not be required to otherwise cut the groove omitted because of the failed blade. Should two or more grooving blades on an individual grooving equipment become incapable of cutting grooves, the contractor shall cease operations.

The grooved area of any selected two-foot by 100-foot longitudinal area of pavement specified to be grooved shall not be less than 90 percent of that area. Ungrooved pavement within the selected area shall be limited to that which occurs as a result of pavement irregularities.

(C) Tolerance:

Longitudinal grooving shall begin six inches from the outside edge of pavement or reflective marker and run in a continuous pattern across the lane surface to within six inches of the longitudinal joint. The groove pattern shall be 1/8 inch in width by 3/16 inch in depth with a center-to-center spacing of 3/4 inch. The groove spacing tolerance shall be plus or minus 1/8 inch. The width of the groove shall have a tolerance of plus or minus 1/64 inches. The depth of the groove shall have a tolerance of plus or minus 1/16 inch.

On curves and/or superelevations, the width of the groove may exceed the above dimensions as approved by the Engineer.

If the pavement profile is very uneven, the Engineer may permit a variation in maximum groove depth in areas adjacent to rutted pavement and/or faulted joints.

Grooving shall be terminated a minimum of one foot from all devices in place in the pavement, such as manholes, inlet casting, valve boxes, etc.

402-5.04 Method of Measurement:

Pavement grooving will be measured and accepted by the square yard of grooved pavement. The quantity of grooved pavement will be determined by multiplying the width times the length of the grooved area.

No deduction will be made for grooving omitted at joints, manholes, inlets or other similar installations in the pavement surface.

402-5.05 Basis of Payment:

The accepted quantities of pavement grooving, measured as provided above, will be paid for at the contract unit price per square yard, which price shall be full compensation for the work, complete in place, as specified herein.

402-6 Joint and Crack Sealing:

402-6.01 Description:

The work shall consist of furnishing all materials and sealing longitudinal and transverse weakened-plane and sealing random cracks in existing Portland Cement Concrete Pavement, as specified herein.

402-6.02 Materials:

Joint and crack sealant material shall conform to the requirements of ASTM D6690 Type IV.

402-6.03 Construction Requirements:

(A) General:

Joint to be sealed will be identified by the Engineer. Joint sealing shall be accomplished by first removing old sealant and joint inserts, then refacing and cleaning the joints and installation of new hot-applied sealant.

Cracks will be identified by the Engineer. Crack sealing shall be accomplished by first cleaning the crack followed by installation of new hot-applied sealant.

(B) Joint Preparation Prior to Sealing:

Before sealing, all non-compressible debris shall be removed from the joints to the full depth of the sawed joints. Old sealant shall be removed by using a nominal 1/8 inch wide diamond blade. The joints shall be sawed to the depth of the original sawing. An air compressor utilizing an oil separator shall be used to remove old sealant and any non-compressible materials. Air compressors shall be capable of furnishing a sufficient amount of compressed air to clean the joints properly.

(C) Crack Cleaning Prior to Sealing:

Cracks shall be thoroughly cleaned of loose debris with an air compressor utilizing an oil separator. Air compressors shall be capable of furnishing a sufficient amount of compressed air to clean the crack properly. Areas requiring crack sealing will be determined by the Engineer.

(D) Installation of Sealant:

Sealant compound shall not be placed unless the joint or crack is dry, clean and free of dust. Heating and application of the sealant shall follow the installation instructions from the sealant manufacturer. The joints shall be sealed so that upon completion of the work, the surface of the sealant material will be 1/4 ± 1/8 inch below the adjacent pavement surface.

402-6.04 Method of Measurement:

Joint and crack sealing will be measured by the linear foot.

402-6.05 Basis of Payment:

The accepted quantities of joint and crack sealing, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the work, complete in place.

402-7 Edge Sealing:

402-7.01 Description:

The work shall consist of furnishing all materials and sealing the joints between the Portland Cement Concrete Pavement and the asphaltic concrete distress lane. This work shall be done after the completion of all specified pavement grinding and after all specified rehabilitation of the distress lane or outside shoulder. The work shall be accomplished in accordance with the details shown on the project plans and as specified herein.

402-7.02 Materials:

The edge sealant shall be a hot-applied joint filler conforming to the requirements of ASTM D5078.

402-7.03 Construction Requirements:

(A) General:

Edge sealing shall be accomplished by cleaning the edges and installation of new sealant.

The edge sealant shall not be placed under adverse conditions, which may include but are not limited to rain, snow, freezing weather, and high winds. Edge sealant material shall not be placed when the ambient temperature falls below 40 degrees F. At any time, the Engineer may require that the work cease or that the work day be reduced if weather conditions, either existing or expected, are anticipated to have an adverse effect upon the sealing material.

The edge sealant shall not be placed in cracks which are wet.

(B) Joint Preparation:

Immediately prior to application of the edge sealant material, the contractor shall ensure that the edges are thoroughly cleaned through the full depth of the edge. Loose particles, grass, grass roots, weeds, dust and other deleterious substances shall be removed by means of high velocity compressed air, vacuuming, or other methods approved by the Engineer. Compressed air equipment shall have traps or devices to prevent moisture and oil from contaminating the edge surfaces.

Immediately following the cleaning of edges and before the application of sealant, if required, a backer rod composed of an inert, compressible material shall be inserted along the lower portion of the joint groove at a uniform depth as shown on the project plans.

(C) Equipment Requirements:

The sealant material shall be mixed in a kettle or a melter constructed as a double boiler. The kettle or melter shall have a continuous sealant agitation and mixing system to provide uniform viscosity and be capable of maintaining the manufacturers recommended application temperature.

(D) Application of Edge Sealant:

The edge sealant shall be installed at the manufacturer's recommended application temperature.

The edge sealant shall be flush or recessed with the surrounding pavement, as approved by the Engineer.

402-7.04 Method of Measurement:

Edge sealing will be measured by the linear foot.

402-7.05 Basis of Payment:

The accepted quantities of edge sealing, measured as provided above, will be paid for at the contract unit price per linear foot, of which price shall be full compensation for the work, complete in place.

SECTION 403 ASPHALTIC CONCRETE HOT PLANT REQUIREMENTS:

403-1 Description:

When referenced in individual specifications, the asphaltic concrete hot plant shall meet the requirements specified herein.

403-2 Requirements:

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein.

Mineral admixture shall be proportioned by weight.

The mineral admixture shall be added and thoroughly mixed with the mineral aggregate by means of a mechanical mixing device prior to the mineral aggregate and mineral admixture entering the dryer. For all asphaltic concrete mixes except ACFC (specified in Sections 407 and 411 of the specifications) and AR-ACFC (specified in Section 414 of the specifications), the moisture content of the combined mineral aggregate shall be a minimum of 3 percent by weight of the aggregate during the mixing process. For ACFC and AR-ACFC mixes, the mineral aggregate shall be wet with free moisture on the surface of the aggregate just prior to the mixing process. To ensure that adequate mixing water is available on the surface of the aggregate, the Engineer may require that the mineral aggregate for ACFC and AR-ACFC mixes have a moisture content of up to 1-1/2 percent above the combined water absorption.

The mineral admixture shall be weighed utilizing an approved weigh system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer which is in good working condition and which consists of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles, without the aid of conveyor belts, for a distance of at least 3 feet. The rate of aggregate feed shall not exceed the mixing device's rated capacity in tons per hour. The mixer shall be constructed to minimize the loss of mineral admixture. The mixer shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected on a belt prior to entry into the dryer. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates.

A positive signal system shall be provided and utilized during production whereby the mixing shall automatically be stopped if the mineral admixture is not being introduced into the mineral aggregate. The plant will not be permitted to operate unless the signal system is in good working condition.

The contractor's plant and equipment shall be constructed and operated so that there is not a significant loss of mineral admixture through the dust collection system of the plant.

For mixing plants other than batch plants, bituminous material and mineral aggregate shall be proportioned by either volume or weight.

When a batch plant is used, bituminous material and mineral aggregate shall be proportioned by weight. Weighing shall be performed with all receptacles and scales insulated against the vibration or movement of the rest of the plant. The insulated receptacles and scales shall be such that the error in weighing, while the entire plant or any part of the plant is operating, shall not exceed 2 percent for the bituminous material and the individual mineral aggregate components, or 1-1/2 percent for any batch. Weighing of bituminous material shall be done in a heated, insulated bucket suspended from a springless dial scale system.

Mineral aggregate from each individual stockpile/hot bin shall be properly proportioned and introduced into the asphaltic concrete.

A positive signal system shall be provided and utilized during production to indicate the low level of mineral aggregate in the bins. The plant will not be permitted to operate unless the signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The introduction of bituminous material shall be controlled by an automated system fully integrated with the controls for mineral aggregate and mineral admixture.

The contractor shall provide daily documentation of the weight and proportion of each individual component (mineral aggregate, mineral admixture, and bituminous material) incorporated into the mix, within three days of the production, excluding weekends and holidays. When a dedicated plant is being used, plant startup waste shall be shown in the hot plant documentation. In addition, when reclaimed asphaltic pavement (RAP) is used, the contractor shall provide daily documentation of the weight, determined by a calibrated or certified belt scale, and proportion of material from each individual RAP stockpile incorporated into the mix. The percent moisture content of the RAP material from each stockpile shall also be determined and provided daily by the contractor.

When Warm Mix Asphalt (WMA) technologies are used, the contractor shall provide the percent of water (for WMA water foaming processes) and/or the percent of WMA additive incorporated in the mix. The percent of each WMA technology shall be reported either by weight of total mix or by weight of total binder.

When incorporating WMA technologies, the hot plant shall be modified as required by the WMA technology manufacturer to introduce the WMA

technology. Plant modifications may include additional plant instrumentation, the installation of asphalt binder foaming systems and/or WMA additive delivery systems, adjusting the plant burner and/or the mixing drum flights in order to operate at lower production temperatures, and/or reducing the production rate of WMA.

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials.

Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

A continuous recording pyrometer sensitive to a rate of temperature change not less than 10 degrees F per minute shall automatically record the temperature of asphaltic concrete or mineral aggregate at the discharge chute of the dryer. A copy of the pyrometer reading shall be provided to the Engineer daily.

If the asphaltic concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphaltic concrete will be minimized.

403-3 Measurement and Payment:

No measurement or direct payment will be made for providing a hot plant meeting the requirements specified herein, the cost being considered as included in the respective contract items.

SECTION 404 BITUMINOUS TREATMENTS:

404-1 Description:

The work under this section shall consist of furnishing all materials and constructing or applying bituminous treatments at the locations designated on the plans and in accordance with the requirements of the specifications and in conformity to the lines shown on the project plans or established by the Engineer.

The bituminous treatments include one or a combination of prime coat, tack coat, and fog coat. The bituminous treatments also include emulsified asphalt chip seal and hot applied chip seal both either with or without fog coat.

When a “hot applied” chip seal is called for on the plans and specifications, it refers to a chip seal using a performance grade asphalt cement or a crumb rubber asphalt as the bituminous material.

404-2 Materials:

404-2.01 Bituminous Materials:

The bituminous material shall be of the type and grade specified in the Special Provisions and shall conform to the requirements of the following subsections:

Asphalt Cement	1005-3.01
Liquid Asphalt	1005-3.02
Emulsified Asphalt	1005-3.03
Emulsified Asphalt (Special Type)	1005-3.04
Recycling Agents	1005-3.05
Emulsified Recycling Agents	1005-3.06
Crumb Rubber Asphalt	1009-2

Application temperatures of bituminous materials shall conform to the requirements of Table 1005-6. Polymer modified bituminous materials shall not exceed 390 degrees F, or less as specified by the supplier.

If emulsified asphalt of any type is held overnight, it shall be reheated and agitated prior to further application.

404-2.02 Aggregate Materials:

(A) General:

The contractor shall provide a source of aggregate material in accordance with the requirements of Section 1001 of the specifications.

With the exception of precoated cover material, aggregate material shall be sampled for gradation acceptance from the final stockpile prior to being incorporated into the work. The aggregate for the precoated material shall be sampled prior to precoating.

(B) Blotter Material:

Blotter material shall be natural or manufactured sand, volcanic cinders, or other approved material and shall be free of deleterious materials or foreign substances.

The gradation shall meet the following requirements when tested in accordance with the requirements of AASHTO T 11 and AASHTO T 27:

Sieve Size	Percent Passing
3/8 inch	100
No. 4	80 - 100
No. 16	45 - 80
No. 200	0 - 5.0

(C) Cover Material:

Aggregate for cover material shall be of clean gravel or crushed rock, shall be free of clay, and shall not contain calcium carbonate, caliche, synthetic materials, organic matter, or foreign substances. Cover material shall not be obtained from sweepings of previously applied cover material.

The gradation shall meet the following requirements when tested in accordance with the requirements of AASHTO T 11 and AASHTO T 27.

Sieve Size	Percent Passing	
	Class 1	Class 2
3/4 inch	100	
1/2 inch	97 – 100	100
3/8 inch	70 – 100	97 – 100
1/4 inch	0 – 10	70 – 100
No. 8	0 – 5	0 – 5
No. 200	0 – 2.0	0 – 2.0

Cover material shall meet the following requirements:

Aggregate Characteristics	Test Method	Requirement
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Carbonates	Arizona Test Method 238	Maximum 20%
Fractured Coarse Aggregate Particles	AASHTO T 335	Minimum 75% one fractured face, determined on plus No. 8 material
Flakiness Index	Arizona Test Method 233	Maximum 20%
Bulk Oven Dry Specific Gravity	AASHTO T 85	2.350 – 2.850
Water Absorption	AASHTO T 85	0 – 2.5%

(D) Precoated Cover Material:

For hot applied chip seals, the cover material shall be precoated with any grade of PG asphalt cement which meets the requirements of Section 1005 of the specifications. The precoating shall be accomplished by mixing at a central plant until the aggregate is evenly coated. The cover material shall have a minimum temperature of 250 degrees F at the time of precoating with asphalt cement. The cover material shall be precoated with approximately 0.40 to 0.60 percent asphalt cement, by weight of the aggregate. The final percentage of asphalt cement used for precoating will be as directed by the Engineer.

Precoated cover material shall be dust free upon completion of coating and shall remain dust free prior to being incorporated into the work.

The aggregate for precoated cover material shall meet the requirements in Subsection 404-2.02(C) of the specifications prior to precoating with bituminous material.

No precoated cover material shall be stockpiled following precoating with asphalt cement for more than five calendar days prior to placement, unless otherwise approved by the Engineer.

404-2.03 Bituminous Treatment Material Types and Application Rates:

The type of bituminous material for tack coat and approximate application rate shall be as specified in Subsection 404-4.02 of the specifications.

The type of bituminous materials for prime coats, fog coats, and emulsified or hot-applied chip seals, along with their respective application rates for liquids, blotter material, and cover material, shall be as specified in the Special Provisions.

The bituminous material application rates provided in the Special Provisions are approximate, and are to be used for bidding purposes, and shall be modified as required herein. Final application rates for all materials shall be those required to ensure the most favorable outcome, as approved by the Engineer.

404-3 Construction Requirements:

404-3.01 Seasonal and Weather Limitations:

(A) General:

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the bituminous treatment.

Placement shall cease for the remainder of the day if sustained wind velocities in excess of 15 MPH occur at the project site.

(B) Prime Coat:

Bituminous material used for prime coats shall be applied to an existing aggregate surface only when the ambient temperature in the shade is at least 70 degrees F and when the existing aggregate surface is slightly damp.

(C) Fog Coat:

Bituminous material used for fog coats shall be applied to an existing pavement surface only when the surface is dry, the pavement surface temperature is at least 60 degrees F but does not exceed 175 degrees F, and the ambient temperature at the beginning of the application is at least 50 degrees F and rising but does not exceed 110 degrees F. The application of bituminous material shall be stopped when the ambient temperature is 55 degrees F or less and falling.

(D) Chip Seal:

The contractor's bid submittal and initial construction schedule shall adhere to the beginning and ending dates shown in Subsection 404-4.04(A) of the specifications. Bituminous material used for chip seal coats shall only be placed when the existing pavement surface is dry, the surface temperature is at least 85 degrees F, and the ambient temperature at the beginning of the application of bituminous material is at least 65 degrees F and rising. The application of bituminous material shall be stopped when the ambient temperature is 70 degrees F or less and falling.

No placement of bituminous material for chip seals shall occur if ambient temperatures are forecasted to be at or below 40 degrees F at any time during the day or night after placement.

For hot applied chip seals, no placement shall occur if ambient temperatures exceed, or are forecasted to exceed, 110 degrees F the day before, the day of, or the two days after placement.

404-3.02 Equipment:

(A) Distributor Truck:

Distributor trucks shall be so designed, equipped, maintained and operated that bituminous material at the specified temperature may be applied uniformly on variable widths of surface at readily determined and controlled rates from 0.03 to 1.00 gallons per square yard, with uniform pressure, and with an allowable transverse variation from any specified rate not to exceed 10 percent or 0.02 gallons per square yard, whichever is less. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of the tank contents. Distributors shall be equipped with a power unit for the pump and a spray bar which is adjustable laterally and vertically. The distributor shall provide for continuous circulation of the bituminous material through the tank and spray bar.

Prior to the spreading of bituminous material, all distributor trucks proposed for use shall have been tested for rate of transverse spread, in accordance with the requirements of Arizona Test Method 411, and

certified within 12 months prior to the date of spreading. Upon certification, an ADOT Bituminous Distribution Truck Certification sticker shall be applied in a clearly visible location inside the driver's side door of the truck. A valid copy of the Certificate of Test (Arizona Test Method 411) shall be carried in the distributor truck. The Engineer may at any time require that each distributor truck be tested to determine the rate of the transverse spread.

All testing and sampling, including the preparation of test pads and test plates, shall be performed by an independent testing laboratory which has been approved by the Engineer to perform Arizona Test Method 411. A professional engineer, registered in the State of Arizona and employed by the independent testing laboratory, shall be responsible for all testing and test results. Testing shall be performed at no cost to the Department.

Distributor truck spray bars shall be equipped with the appropriate size nozzles adjusted to the proper angle with the associated adjustment wrench to achieve maximum overlap of spray and an even application.

Distributor trucks shall have a calibrated thermometer and volume gauge or other device with which the volume of material in the tank may be measured to within 50 gallons. The pump shall be shown to have been verified by a mass flow meter or other acceptable means within the last 12 months. The spray bar shall be adequately flushed of prior materials, solvents, or other contaminants.

Equipment which fails to provide an acceptable application of bituminous material shall be removed from the project.

(B) Power Brooms:

Power brooms shall be of the rotary or pickup type, capable of completely removing excess blotter material, and cleaning without gouging or tearing the surface.

(C) Rollers:

Rollers shall be of the oscillating type having a width of not less than 4 feet with pneumatic tires of equal size and diameter. Wobble-wheel rollers will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. Unless foam filled, the tires shall be inflated per the manufacturer's specifications and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. Pneumatic-tired rollers shall be properly ballasted and constructed so that the total weight of the compactor can be varied to produce an operating weight per tire of not less than 2,000 pounds.

(D) Aggregate Spreaders:

The application of blotter material shall be accomplished by means of a sand slinger or other equipment approved by the Engineer.

The application of cover material shall be accomplished by means of a calibrated spreader. The spreader shall be a self-propelled, computerized rate-controlled unit capable of an application width of 14 feet or greater. The spreader shall be in good mechanical condition, capable of applying the correct aggregate application rate uniformly across the spread width.

Chip spreader boxes shall be calibrated to ensure consistent discharge across all of the chutes except where the discharge is intentionally adjusted to compensate for site conditions and construction operations.

404-3.03 BLANK:

404-3.04 Preparation of the Surface:

The surface to be treated shall be thoroughly cleaned prior to applying the bituminous material. Man holes, utility covers, and catch basins shall be protected prior to and during application of bituminous material. Self-propelled rotary power brooms, pickup brooms, and hand brooms shall be used immediately in advance of applying the bituminous material.

When a bituminous treatment is to be applied to an existing aggregate surface, the surface shall be uniformly smooth, firm and reasonably true to grades and cross sections as shown on the project plans, and shall be so maintained throughout the placing of the bituminous treatment. In no event shall a bituminous treatment be placed on a soft, uneven base. All holes, depressions or irregularities shall be repaired. All loose and unsuitable material shall be removed and replaced by suitable material, which shall be compacted to produce a dense uniform surface conforming to the adjacent area.

When required, the existing aggregate surface on which the bituminous treatment is to be placed shall be lightly bladed, watered and compacted immediately prior to the application of bituminous material. In extremely dry areas, additional light applications of water may be required prior to the application of the bituminous material to facilitate penetration of the bituminous material.

404-3.05 Application of Bituminous Material:

The types, grades, and approximate rates of application of bituminous material shall be as specified in Subsections 404-2.03 of the specifications. The application rates for chip seal coats shall be determined by the contractor in accordance with the requirements herein, subject to approval by the Engineer.

The rates to be applied may vary substantially because of different surface conditions within the project limits. The actual bituminous material application rate shall not vary more than 10 percent from the application rate specified or approved by the Engineer.

The bituminous material shall be uniformly applied to the prepared surface at the rate specified or approved by the Engineer and in one application.

The various types or grades of bituminous materials shall be applied at temperatures within the limits given in Table 1005-6, and at no time shall the contractor increase the temperature of the bituminous material above the higher limit specified.

In order to obtain uniform distribution, the distribution shall be promptly started or stopped at the junction of two applications in a manner that will not result in overlaps or gaps in the applications.

The distribution shall be promptly cut off prior to the decrease in uniform flow caused by the distributor tank becoming empty, when there is a decrease in uniform flow due to any reason, or when the forward movement of the distributor slows down or stops.

In the event that any spots are missed in the application, or any areas develop that do not have a uniform spread or penetration, such areas shall be remedied without delay.

Care shall be taken to prevent the spraying or splattering of bituminous material on adjacent pavements, structures, curb, guardrail, vegetation, or any other object outside of the area designated for spraying.

Removal and disposal of unused bituminous material shall be the contractor's responsibility and at no cost to the Department .

404-3.06 Application of Blotter Material:

The approximate application rate of blotter material, when required as a part of a bituminous treatment, shall be as specified in Subsection 404-2.03 of the specifications; however, the Engineer will specify the exact rate to be applied based on the characteristics of the bituminous treated surface. The specified application rates are based on the wet weight of material.

Blotter material, at the time of spreading, shall be wet but free from running water. Blotter material shall be spread uniformly to the treated surface in one or more applications for a total application rate as specified. Blotter material shall be applied at a time acceptable to the Engineer and before opening to traffic.

Any oversized aggregate or foreign material picked up during stockpiling or loading operations shall be eliminated before entering the spreader.

Supplemental spreading or smoothing shall be done by hand methods where necessary.

Prior to final acceptance and when ordered by the Engineer, the contractor shall remove and dispose of any excess blotter material. Removal and disposal of excess blotter material shall be the contractor's responsibility and at no cost to the Department.

404-3.07 Joints:

(A) General:

Transverse joints with the preceding work, at intersections, and at all existing pavements and structures shall be made by a method approved by the Engineer prior to the start of the work.

Longitudinal joints shall be overlapped between 2 to 6 inches.

Regardless of the width of the roadway to be sealed, the number of longitudinal joints shall be kept to a minimum. Longitudinal joints shall be located to the greatest degree obtainable to coincide with the painted lines between traffic lanes.

(B) Chip Seal:

Unless otherwise directed by the Engineer, transverse joints with the preceding work shall be made by placing building paper over the end of the previous application, and the joining application shall start on the building paper. Once the application process has progressed beyond the paper, the paper shall be disposed of as directed by the Engineer. Transverse joints at other locations shall be made by a method approved by the Engineer prior to the start of the work.

Joints shall be cleaned as deemed necessary by the Engineer prior to the application of bituminous material in the adjacent strip.

404-3.08 Opening to Traffic:

In the construction or application of bituminous treatments, no traffic or equipment will be permitted on the treated roadway surface until it has been established to the satisfaction of the Engineer that the treated roadway surface will not be damaged or marred under the action of traffic. No traffic of any description shall be allowed on any bituminous treatment until approved by the Engineer.

404-4 Bituminous Surface Treatment:

404-4.01 Prime Coat:

The type of bituminous material and the approximate application rate shall be as specified in Subsection 404-2.03 of the specifications. The Engineer may adjust the actual application rate based on specific trials and visual observations performed on test areas for different base conditions.

When it is deemed necessary, areas having excess bituminous material shall be blotted with material as directed by the Engineer.

When directed by the Engineer, the surface of the completed prime coat shall be rolled with a pneumatic-tired roller.

The integrity of the prime coat shall be maintained at all times until the next course is placed or until final acceptance. In the event traffic has caused holes or breaks in the surface, such holes or breaks shall be repaired by the contractor.

404-4.02 Tack Coat:

Tack coat shall be applied prior to placing a bituminous mixture on a primed surface, an existing bituminous surface, or an existing Portland cement concrete pavement surface. Tack coat shall also be applied between each layer of bituminous mixtures. A light coat of bituminous material shall also be applied to edges or vertical surfaces against which a bituminous mixture is to be placed.

The contractor shall choose the bituminous material to be used for tack coat. The Engineer must approve the contractor's choice of bituminous material prior to its use.

The rate of application for the specific usage will be specified by the Engineer. The following table shows approximate tack coat application rates:

Type of Bituminous Material	Approximate Tack Coat Application Rates: Gallons / Square Yard		Payment Factor
	Prior to Placing ACFC or AR-ACFC	All Other Tack Coats	
Emulsified Asphalt (Special Type) – See Note (1) Below.	Not Allowed	0.12	0.7
Emulsified Asphalt (Other than Special Type)	0.08	0.08	1.0
Asphalt Cement	0.06 to 0.08	0.06 to 0.08	1.0
Note:			

(1) Emulsified Asphalt (Special Type) shall consist of Type SS-1 or CSS-1 emulsified asphalt diluted with water to provide an asphalt content of not less than 26 percent.

The Engineer may adjust the application rate.

If emulsified asphalt of any type is used, it shall have broken before the bituminous mixture is placed.

Tack coat shall be applied only as far in advance of the placement of the bituminous mixture as is necessary to obtain the proper condition of tackiness. All traffic on a tack coat surface shall be minimized to the greatest extent possible. In no event shall more tack coat be applied in one day than will be covered by the bituminous mixture during that same day.

404-4.03 Fog Coat:

The type of bituminous material and the approximate application rate shall be as specified in Subsection 404-2.03 of the specifications. The material shall be diluted with one part water to one part bituminous material. The specified application rate is based on the diluted material. The Engineer may adjust the actual application rate based on specific trials and visual observations performed on test areas for different pavement conditions.

When specified in Subsection 404-2.03 of the specifications, blotter material shall be applied following the application of bituminous material.

404-4.04 Chip Seal Coat:

(A) General:

The contractor shall prepare their bid submittal and initial construction schedule, submitted at the Preconstruction Conference as described in Subsection 108.03 of the specifications, based on the following beginning and ending dates for placement of the chip seal.

Average Elevation of Project, Feet	Beginning and Ending Dates
0 – 3499	March 15 – May 31
0 – 3499	September 1 – October 31
3500 – 4999	May 1 – September 30
5000 and over	June 1 – August 31

Any proposed placement deviating from the beginning and ending dates shall be detailed in the written schedule of construction submitted at the weekly meeting described in Subsection 108.04 of the specifications. No contract time extension will be granted for placement outside of the

beginning and ending dates. Any placement deviating from the beginning and ending dates shall be at the sole risk of the contractor.

The type of bituminous material and the approximate application rate shall be as specified in Subsection 404-2.03 of the specifications. The type of cover material shall be as specified in Subsection 404-2.03 of the specifications.

The contractor shall determine the application rates and corresponding quantities of bituminous material and cover material for chip seal coat in accordance with Arizona Test Method 819. Application rates are subject to approval by the Engineer. Areas and locations anticipated to require adjustment to the rate(s) shall also be identified.

The application rates and performance of emulsified asphalt chip seals shall be evaluated using the Sweep Test in accordance with ASTM D7000.

The performance of hot applied chip seals shall be verified using the Vialit Retention Test in accordance with EN 1272-3, modified as necessary to account for the specific characteristics of the proposed chip seal.

The actual application rate shall be such that the aggregate is embedded approximately 70 percent (80 percent above 4,000 feet elevation) and excessive tracking of bituminous material does not occur under construction equipment or when opened to traffic.

The actual rate of cover material to be applied shall be such that no more than 5 percent of the chips applied are removed during sweeping and approximately 20 percent void space exists between the aggregate particles once realigned after opening to traffic.

The proposed application rate(s), locations requiring adjustment, and the associated basis for each adjustment, shall be submitted to the Engineer for approval no later than five days following completion of the Pre-Activity Walkthrough as described in Subsection 404-4.04(B) of the specifications and at least five days prior to placement of the test strip.

The basis for any anticipated adjustments shall include use of one or more of the following:

(a) Sand Patch tests performed in accordance with STP762 Pavement Surface Characteristics and Materials; Haydon, C.E. (ASTM, 1982),

(b) Appendix B of Chip Seal Guide for Application and Construction; Pavement Preservation Committee of the Arizona Chapter of The Associated General Contractors (AGC-Arizona Chapter, 2013),

(c) Arizona Test Method 742 for mean macrotexture.

The approved application rate(s) and adjustments shall be clearly marked at the corresponding locations and remain visible to equipment operators prior to placement.

At least 10 days prior to chip seal placement, the contractor shall submit a minimum 75-pound sample of uncoated cover material to the Engineer for testing. In addition to the submitted cover material, the contractor shall also submit 3 full gallons of emulsion (5 to 8 gallons for hot applied) in 1-gallon cans in accordance with the requirements of AASHTO R 66. The contractor shall also submit 40 pounds of granulated rubber if included in the bituminous material.

(B) Pre-Activity Walkthrough:

Prior to placement, the contractor shall conduct a Pre-Activity Walkthrough with all parties expected to work on the chip seal.

Locations where adjustments in application rate may be appropriate shall be documented.

A location for a test strip, approximately 1,000 feet in length shall be identified. If additional test strip locations are desired due to varying surface conditions, these shall also be identified.

Other factors or site conditions such as turn or deceleration lanes, changes in surface characteristics, crack fill, and recent patchwork which may affect placement of the chip seal coat shall also be identified. A description of any affecting conditions and the corresponding locations and action to be taken to minimize their impact shall be documented.

In addition to the requirements herein, the items contained on the checklists provided in AGC-Arizona Chapter's Chip Seal Guide for Application and Construction shall be considered.

(C) Chip Seal Test Strip:

Prior to the start of placement, all equipment used in the placement of the chip seal coat shall be verified to be in satisfactory operating condition and in accordance with the requirements herein.

Cover material shall be verified to have appropriate moisture and be in a condition consistent with that in which it existed at the time initial acceptance samples were obtained. Bituminous material certifications shall be verified to indicate that the required type of material is on hand. The bituminous material shall be at the proper temperature prior to application.

The chip seal test strip shall be a minimum of 500 linear feet. The existing pavement surface to receive the test strip shall be verified to have been adequately swept and cleaned and meeting the requirements

herein. Anticipated application rates shall have been marked and clearly visible to equipment operators.

During placement of the test strip, all equipment shall be observed to confirm proper operation. The application rate of both the bituminous material and cover material shall be measured and verified using a catch-and-weigh “tarp” method. The application rate of the bituminous material shall also be measured and verified by means of a volume per area calculation using the distributor trucks calibrated thermometer and volume measuring gauge or device.

Rolling shall immediately follow placement of the cover material and be verified to be in conformance with the requirements herein.

For emulsion chip seals, the contractor shall broom the surface to remove excess cover material only after the emulsion has fully broken and cured sufficiently for maximum chip retention.

Prior to any subsequent placement, the test strip shall be observed to have adequate embedment of the cover material without excessive void space between the chips, stacking of chips, or accumulation of chips on the shoulders. If the condition of the test strip is not acceptable, adjustments shall be made as appropriate, and an additional test strip shall be performed.

(D) Application of Bituminous Material for Chip Seal:

The following bituminous material application requirements for chip seal are in addition to the requirements specified in Subsection 404-3.05 of the specifications.

Bituminous material shall not be applied a distance ahead of the chip spreader that results in excessive lag of the rollers allowing hot applied bituminous material to cool or emulsified bituminous material to break prior to achieving adequate embedment of the cover material.

When inclement weather is expected, only the amount of hot applied bituminous material which can receive adequately embedded cover material, or only the amount of emulsified asphalt that can receive adequately embedded cover material and has sufficiently broken, shall be placed prior to the start of inclement weather.

(E) Application of Cover Material:

Cover material shall be immediately and uniformly spread over the freshly applied bituminous material such that aggregate particles are securely adhered and will not roll, tumble, or be picked up during the rolling process. Any oversize aggregate or foreign material picked up during stockpiling or loading operations shall be eliminated before entering the aggregate spreader hopper. Supplemental spreading and smoothing shall be done by hand methods where necessary.

When emulsified asphalt is used, the cover material shall be at a saturated surface-dry condition at the time of spreading.

For hot applied chip seals, and when project conditions require, precoated cover material shall be at a sufficient temperature to facilitate adequate embedment.

(F) Rolling Cover Material:

Following the spreading of cover material, the surface shall be promptly rolled with self-propelled pneumatic-tired rollers. A minimum of three rollers shall be provided; however, a sufficient number of rollers shall be provided to cover the entire width of the material spread in one pass of the compactors and rolling shall continue until a minimum of three passes has been completed.

For chip seals with a hot applied bituminous material the first roller pass shall occur as soon as possible but no longer than 2 minutes after applying the aggregate. The third pass shall be completed quickly enough to embed the aggregate before the binder cools, and no longer than 15 minutes after the binder is applied.

(G) Removal of Loose Cover Material:

The cover material shall be removed by means of a power broom which shall be in good condition and of a design suitable for the work. The action of the broom shall be such that particles which are stuck to the bituminous material will not be dislodged.

For chip seals with an emulsified bituminous material, initial removal of all loose cover material shall not commence prior to two hours after placement or at such time that the Engineer has determined that the emulsion has sufficiently cured.

For chip seals with a hot applied bituminous material, the removal of loose cover material shall commence approximately 30 minutes after the final rolling is completed.

Initial removal of loose cover material shall occur prior to opening to traffic. All loose cover material shall be removed from the paved surface by brooming within 24 hours after application.

After the traffic free period as specified in Subsection 404-4.04(H) of the specifications, but prior to final removal of loose cover material, all traffic permitted by the Engineer shall not exceed 25 miles per hour.

If the Engineer determines that conditions are not conducive to obtaining the best results, brooming shall be discontinued until the Engineer has considered all conditions and has determined the best time for the removal of the cover material.

(H) Minimum Traffic-Free Period:

The minimum traffic-free period for a newly applied emulsion chip seal coat shall be three hours. The contractor's hauling equipment may use the new seal coat surface during the traffic free period at a speed not to exceed 15 miles per hour but shall not make sharp turns of brake abruptly.

(I) Fog Coat on New Chip Seals:

When specified in Subsection 404-2.03 of the specifications, a fog coat shall be placed on the new chip seal following the curing period. The type of bituminous material and the approximate application rate shall be as specified in Subsection 404-2.03 of the specifications. The material shall be diluted with one part water to one part bituminous material. The specified application rate is based on the diluted material. The Engineer may adjust the actual application rate based on specific trials and visual observations performed on test areas for different pavement conditions.

When specified in Subsection 404-2.03 of the specifications, blotter material shall be applied following the application of bituminous material.

(J) Contractor Quality Control:

The contractor shall be responsible for the chip seal design, performing quality control testing on materials, and designating an individual charged with constant observation and monitoring.

Need for an adjustment to application rates or a correction to process or equipment shall be communicated immediately to the necessary personnel.

The initial condition of equipment, materials, and the project and pavement surface conditions shall be documented. The performance and results of the test strip shall be documented. Observations of monitoring activities and quantification of application rates during the test strip and production shall be documented no less frequently than every other placement run.

The cause for any adjustments, including quantifying tests performed, the adjustments made, and the result of such adjustments with regard to acceptability and performance of the chip seal coat shall be documented.

404-5 Method of Measurement:

Bituminous materials will be measured by the ton.

Bituminous material that is required to be diluted prior to application will be measured by the ton of diluted material.

Cover material will be measured by the square yard.

The contractor shall be responsible to determine the amount of cover material that will be required to complete the work from the source(s) from which the cover material is obtained.

Blotter material, when required, will be measured by the square yard.

Measurement for payment will be made only for the quantity of bituminous material and for the quantity of aggregate material used in accordance with the requirements of the specifications.

Time to apply tack coat, when required, is defined as the hours within a work shift that an approved distributor truck containing the specified bituminous material is required by the Engineer to be at the work site.

The time which is required to apply tack coat, when required, will be measured to the nearest hour for the actual number of hours required in any one work shift; however, when the time required is less than four hours in any workday, the time will be measured as four hours.

404-6 Basis of Payment:

The accepted quantities of the work under this section, complete in place, measured as provided above, will be paid for at the contract unit price as designated in the bidding schedule, except the contract unit price for the quantities of bituminous material will be adjusted on the basis of the test results in accordance with the requirements of Section 1005 of the specifications.

No measurement or direct payment will be made for precoating the cover material, material for precoating, rolling and removal of loose cover material, and removal of loose blotter material.

The contract unit price for each item of bituminous material except tack coat will be considered to include all costs for furnishing, hauling, handling, spreading, and mixing of the material as required.

The unit price for bituminous tack coat is deemed to be the cost to furnish, transport, and store asphalt cement or emulsified asphalt at the project location. Payment for bituminous tack coat will be made at the unit price multiplied by the respective payment factor listed under Subsection 404-4.02 of the specifications, and adjusted to the nearest dollar.

Unless otherwise specified, the accepted quantity of bituminous tack coat, measured as provided above, will be paid at the contract unit price

per ton adjusted as provided above which price shall be full compensation for furnishing, transporting, and storing the exact type, grade or designation of bituminous tack coat specified by the Engineer.

Unless otherwise specified, the accepted quantity of time to apply bituminous tack coat, measured as provided above, will be paid for at the contract unit price per hour which payment shall be full compensation for applying bituminous tack coat.

The bidding schedule quantity for tack coat is based on an estimated application rate of 0.06 gallons per square yard for each application shown on the project plans.

The unit price of bituminous material will be adjusted in accordance with the requirements of Subsection 109.16 of the specifications based on the "initial cost" of bituminous material between the date of bid opening and the date that the material is used on the project.

No measurement or direct payment will be made for furnishing, applying and removing blotter material, furnished in conjunction with the application of a prime coat.

No measurement or direct payment will be made for the maintenance or repair of a prime coat surface.

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SECTION 407 ASPHALTIC CONCRETE FRICTION COURSE:

407-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete Friction Course, hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt cement) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications, and as directed by the Engineer.

407-2 Asphaltic Concrete Mix Design:

Mix designs will be developed on the basis of and tested in accordance with the requirements of Arizona Test Method 814. The allowable range

of percent absorbed asphalt shall be 0-1.0, when tested in accordance with Arizona Test Method 806.

407-3 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated as specified in the Special Provisions.

407-3.01 Mineral Aggregate:

The contractor shall provide a source of mineral aggregate in accordance with the requirements of Section 1001 of the specifications.

When the contractor selects a source or sources, it shall notify the Engineer. The contractor shall be solely responsible for assuring that the mineral aggregate meets all requirements and, when processed, is fully capable of providing asphaltic concrete which meets all the requirements of these specifications.

Mineral aggregate shall be separated into at least two stockpiles. No individual stockpile or hot bin usage shall be less than 3 percent of the total mineral aggregate.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate or blend material shall consist of natural sand, sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

Mineral aggregate furnished for mix designs shall be representative of the source(s) and sampled from the material stockpiles to be used in asphaltic concrete production. Mix designs shall conform to the grading limits in Table 407-1, when tested in accordance with AASHTO T 11 and AASHTO T 27.

TABLE 407-1
MIX DESIGN GRADING LIMITS

Sieve Size	Percent Passing	
	Without Admixture	With Admixture
3/8 Inch	100	100
No. 4	35 – 55	36 – 55
No. 8	9 – 14	10 – 15
No. 200	0 – 2.0	0 – 3.0

Mineral aggregate shall conform to the requirements in Table 407-2 when tested in accordance with the applicable test methods.

Tests on aggregates outlined in Table 407-2, other than abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on samples from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

TABLE 407-2
MINERAL AGGREGATE CHARACTERISTICS

Characteristic	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity	Arizona Test Method 251	2.350 – 2.850
Combined Water Absorption	Arizona Test Method 251	0 – 2.5%
Sand Equivalent	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 8 material is required.)	Minimum 55
Fractured Coarse Aggregate Particles	AASHTO T 335	Minimum 85% (at least two fractured faces) and minimum 92% (at least one fractured face)
Flakiness Index	Arizona Test Method 233	Maximum 25%
Carbonates	Arizona Test Method 238	Maximum 20%
Abrasion	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%

407-3.02 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate. Mineral admixture shall be either Portland cement, blended hydraulic cement, or hydrated lime conforming to the requirements of Table 407-3.

TABLE 407-3
MINERAL ADMIXTURE

Material	Requirement
Portland Cement, Type I or II	ASTM C150
Blended Hydraulic Cement, Type IP	ASTM C595
Hydrated Lime	ASTM C1097

Certification and acceptance of Portland cement, blended hydraulic cement, and hydrated lime shall be in accordance with ADOT Materials Practice and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

407-3.03 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder, conforming to the requirements of Section 1005 of the specifications. The type of asphalt binder shall be as shown in the Special Provisions.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

The percent of asphalt cement to be used will be specified by the Engineer.

407-4 Mix Design:

Approximately 300 pounds of produced mineral aggregate, in proportion to the anticipated percent usage, shall be obtained by the contractor and witnessed by the Engineer so that both parties are satisfied that samples are representative of the mineral aggregate to be utilized in the asphaltic concrete production.

In addition to the mineral aggregate samples, the contractor shall also furnish the Engineer with representative samples of the following materials: 3 gallons of asphalt cement from the intended supplier, and a 1-gallon can of the proposed mineral admixture. These materials must be representative of the material which will subsequently be used in the production of asphaltic concrete.

If the mineral aggregate does not meet the requirements of Subsection 407-3.01 of the specifications, no mix design will be prepared. The contractor shall take the necessary steps to provide material meeting the specified requirements.

Along with the samples furnished for mix design testing, the contractor shall submit a letter explaining in detail its methods of producing mineral aggregate including wasting, washing, blending, proportioning, etc., and any special or limiting conditions it may propose. The contractor's letter shall also state the source(s) of mineral aggregate, the source and type of asphalt cement, and the source and type of mineral admixture.

Within 10 working days of receipt of all samples and the contractor's letter in the Central Laboratory, the Department will provide the contractor with a mix design containing the type, source, and percentage of asphalt cement; the type, source, and percentage of mineral admixture; the source(s) of mineral aggregate and the percentage from each stockpile; the composite mineral aggregate gradation; the combined mineral aggregate and mineral admixture gradation; and any special or limiting conditions.

The contract time established for the completion of the work includes 10 working days for the required testing and the developing of the approved mix design.

Asphaltic concrete friction course production shall not begin until there is an approved mix design.

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing mineral aggregate have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of the project.

407-5 Mix Design Revisions:

At any time after production of asphaltic concrete has been started using the approved mix design, changes may be proposed by the contractor or directed by the Engineer.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer, or without requesting a new mix design.

If the contractor elects to change its source or type of bituminous material, the type of mineral admixture, or the source(s) of mineral aggregate, or if the contractor adds or deletes the use of a mineral aggregate stockpile(s) regardless of source, testing to the extent deemed necessary by the Engineer will be performed in order that the Engineer may be satisfied that the mix design criteria will be met.

During production of asphaltic concrete the contractor, on the basis of field test results, may request a change to the approved mix design. The Engineer will evaluate the proposed changes and notify the contractor of the Engineer's decision within two working days of the receipt of the request.

If, at any time, unapproved changes are made by the contractor in the source or type of bituminous material, source(s) of mineral aggregate, production methods, or proportional changes in violation of approved

mix design stipulations, production shall cease until a new mix design is developed at no additional cost to the Department, or the contractor complies with the approved mix design.

At any time after the mix design has been approved, the contractor may request a new mix design. The costs associated with the testing of materials in the developing of mix designs requested by the contractor after a mix design acceptable to the Department has been developed shall be borne by the contractor.

If the Engineer determines that a new mix design is necessary due to changes in mineral aggregate characteristics or gradation, costs associated with the development of the new mix design shall be borne by the contractor.

A new mix design can be developed by the Engineer at any time the Engineer deems necessary. Should such a new mix design require revisions to the contractor's operations which result in additional cost to the contractor, it will be reimbursed for these costs. However, the Engineer reserves the right to modify the asphalt cement content without compensation being made to the contractor involving additional operation costs.

407-6 Acceptance of Materials:

407-6.01 General:

The contractor's attention is directed to the requirements of Subsection 105.13 of the specifications.

If the production of asphaltic concrete is stopped either for failure to meet the requirements specified in Subsection 407-6.03 of the specifications or because changes are made in the mix design, samples will be taken for calculating new consecutive averages either after production resumes or after the changes in the mix design have been made. The acceptance of the mineral aggregate gradation and the bituminous material content will be determined on the basis of the tests as specified in Subsection 407-6.03 of the specifications. The Engineer reserves the right to increase the frequency of sampling and testing upon the resumption of asphaltic concrete production.

407-6.02 Mineral Aggregate:

Aggregate shall be free of deleterious materials, clay balls, and adhering films or other material that prevent thorough coating of the aggregate with the bituminous material.

Prior to and during asphaltic concrete production, the Engineer shall obtain and test samples of mineral aggregate for determination of the sand equivalent, fractured coarse aggregate particles, and flakiness index. Samples shall be obtained from the cold feed belt prior to the

addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible. Should such testing indicate results not meeting the requirements of Table 407-2 for sand equivalent, fractured coarse aggregate particles, and flakiness index, operations shall cease and the contractor shall have the option of requesting a new mix design or correcting deficiencies in the aggregate stockpiles.

407-6.03 Asphaltic Concrete:

(A) Mineral Aggregate Gradation:

Prior to the initial startup of asphaltic concrete production, and prior to startup after any subsequent mix design revisions affecting gradation, a sample of the combined mineral aggregate shall be tested. The mineral aggregate shall meet the gradation requirements for the three consecutive test limits indicated below. If the mineral aggregate does not meet these requirements, production shall not begin until the mineral aggregate is in compliance with this requirement.

For each approximate 500 tons of asphaltic concrete produced, at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of AASHTO R 90 on a random basis. For batch plants, the sample shall be taken from the hot bins. For plants other than batch plants, the sample shall be taken from the cold feed belt. Samples will be taken by means of a sampling device which is capable of obtaining representative samples. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphaltic concrete is less than 500 tons, at least one sample will be taken.

Samples will be tested for conformance to the mix design gradation, with or without mineral admixture as appropriate, in accordance with the requirements of AASHTO T 11 and AASHTO T 27.

The gradation will be considered to be acceptable unless the average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests	
	Three Consecutive	One
No. 4	± 4	± 6
No. 8	± 4	± 6
No. 200	± 1.5	± 2.0

One hundred percent of the material shall pass the 3/8-inch sieve.

At any time that test results indicate that the gradation does not fall within all of the limits indicated, the production of asphaltic concrete shall cease immediately and shall not begin again until a calibration test indicates that the gradation is within the three consecutive test limits indicated.

(B) Bituminous Material Content:

During production of asphaltic concrete, the contractor shall maintain at the plant site a nuclear asphalt content gauge calibrated and operated in accordance with AASHTO T 287. At the discretion of the Engineer, the Department may choose to prepare the calibration samples for use by the contractor. Under the observation of the Engineer, the contractor shall determine the asphalt content by means of the nuclear asphalt content gauge a minimum of four times per full shift. The Engineer shall determine the times that the samples are taken. The contractor's technicians performing the testing, including the calibration of the nuclear gauge, shall meet the technician requirements given in ADOT Materials Practice and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

Production of asphaltic concrete shall cease immediately and the plant and/or the nuclear asphalt content gauge re-calibrated if any single test result varies by an amount greater than ± 0.60, or the average of three consecutive test results varies by an amount greater than ± 0.40, from the amount directed by the Engineer. Material that has already been produced may be used on the project if the single test value representative of that material varies by an amount from ± 0.61 to ± 0.75, inclusive, from the amount directed by the Engineer. Material that has already been produced may not be used on the project if the single test value representative of that material varies by an amount greater than ± 0.75 from the amount directed by the Engineer unless, by retesting, the material is found to be acceptable.

407-6.04 Material Spread:

The estimated target spread rate will be as shown in the table in Subsection 407-3 of the specifications. The Engineer may adjust the estimated target spread rate, and establish a new target spread rate, as necessary to maintain a suitable thickness.

The thickness behind the screed shall be measured by the contractor continuously throughout each spread lot to ensure that the minimum compacted thickness specified in Subsection 407-3 of the specifications is being met.

A spread lot shall be considered to be one-half shift of production. The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, target spread rate, and tons placed in each spread lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the target spread rate.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A spread lot will be considered to be acceptable if the actual quantity placed does not vary by more than +5.0 percent from the required quantity.

407-7 Construction Requirements:

407-7.01 Quality Control:

Quality control of mineral aggregate production and asphaltic concrete production shall be the responsibility of the contractor. The contractor shall perform sufficient testing to assure that mineral aggregate and asphaltic concrete are produced which meet all specified requirements. The Engineer reserves the right to obtain samples of any portion of any material at any point of the operations for the Engineer's own use.

407-7.02 Stockpiling:

The contractor will not be allowed to feed the hot plant from stockpiles containing less than two full days of production unless only two days production remain to be done or special conditions exist where the Engineer deems this requirement waived.

Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

407-7.03 Proportioning, Drying, Heating, and Mixing:

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the specifications.

Unless approved by the Engineer, no individual mineral aggregate stockpile or hot bin usage shall be less than 3 percent of the total mineral aggregate.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless the collected fines are accurately and uniformly metered into the mixture.

The moisture content of the asphaltic concrete shall not exceed 0.5 percent. The moisture content will be determined in accordance with the requirements of AASHTO T 329.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the dryer shall not exceed 275 degrees F (325 degrees F when PG TR+ asphalt cement is used), unless otherwise approved by the Engineer.

407-7.04 Placing and Finishing:

(A) General Requirements:

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

All wheels and tires of compactors shall be wetted with water, or if necessary soapy water, or a release agent in order to prevent the sticking of asphaltic concrete. All other equipment surfaces shall be treated when necessary with a release agent. Only release agents evaluated through AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) are acceptable for use. The results from AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) testing, when tested in accordance with AASHTO T 383, shall conform to the requirements shown in the table below.

RELEASE AGENT TEST	REQUIREMENT
Asphalt Stripping Test Diluted Non-Diluted (Full Strength)	 No Stripping No Stripping
Asphalt Performance Test	Less than or equal to 10.0% after the third cycle

Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with bituminous material in accordance with the requirements of Section 404 of the specifications.

Unless otherwise specified on the project plans, asphaltic concrete shall not be placed on the 2-foot widened section where guardrail is to be installed.

(1) Placement Dates and Weather Requirements:

Asphaltic concrete shall be placed when the temperature of the surface on which the asphaltic concrete is to be placed is at least 85 degrees F and the ambient temperature at the beginning of placement is at least 70 degrees F and rising. The placement shall be stopped when the ambient temperature is 75 degrees F or less and falling. Night time placement may occur during falling temperature if the low temperature is 70 degrees F or higher.

No placement of asphaltic concrete shall occur if ambient temperatures are forecasted to be at or below 40 degrees F at any time during the day or night after placement.

No placement of asphaltic concrete shall occur if ambient temperatures exceed, or are forecasted to exceed, 110 degrees F the day before, the day of, or the day after paving.

No placement of asphaltic concrete shall occur if sustained wind speeds in excess of 15 MPH are forecast on the day of the scheduled placement. However, the Engineer may allow placement of asphaltic concrete during high wind conditions if the ambient temperature is 85 degrees F and rising.

No asphaltic concrete placement shall take place if rain occurs at any time in the two days prior to the scheduled placement of the asphaltic concrete, nor shall placement be expected to occur if rain is forecast during the proposed day of placement. However, at the discretion of the Engineer, placement may commence if actual conditions are conducive to placement.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions are anticipated to have an adverse effect upon the asphaltic concrete.

Unless otherwise directed by the Engineer, no traffic (including construction traffic, with the exception of required striping equipment) shall be allowed on the AR-ACFC overlay until at least eight hours after the placement of AR-ACFC. The Engineer may reduce this time for materials placed on ramps and auxiliary lanes, or for traffic related purposes. Prior to opening to any traffic, the Engineer may require up to three applications of lime water (a minimum of 50 pounds of lime per 2,000 gallons of water). Reasons may include, but are not limited to, opening prior to the eight hour curing time, or ambient temperatures above 100 degrees F. Lime water shall be applied in a manner that uniformly covers the entire surface of the paving pass. No separate payment will be made for lime water or its application, the cost being considered as included in this contract item.

The contractor shall prepare their bid submittal and initial construction schedule, submitted at the Preconstruction Conference as described in Subsection 108.03 of the specifications, based on the following beginning and ending dates for asphaltic concrete production.

Average Elevation of Project, Feet	**Beginning and Ending Dates**
0 – 3499	March 15 – May 31
0 – 3499	September 1 – October 31
3500 – 4999	April 15 – October 15
5000 – 5999	June 1 – September 15
6000 and over	June 1 – August 15

Any proposed placement deviating from the beginning and ending days shall be detailed in the written schedule of construction submitted at the weekly meeting described in Subsection 108.04 of the specifications.

No contract time extension will be granted for placement outside of the beginning and ending dates. Any placement deviating from the beginning and ending dates shall be at the sole risk of the contractor.

(2) Delivery to Screed Unit:

Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps, or migration of the bituminous material. Should any of these conditions be evident in the material delivered to the screed unit, the contractor shall take the necessary corrective action to eliminate such conditions. If any of these conditions persist, the Engineer will order the work to be stopped until satisfactory corrective action has been taken.

(B) Loading Material into the Paving Machine:

If the asphaltic concrete is dumped directly into the paving machine from the hauling trucks, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machines by the trucks. Trucks, while dumping, shall be securely attached to the paving machine.

If the asphaltic concrete is dumped upon the surface being paved and subsequently loaded into the paving machine, it shall not be dumped at a distance greater than 150 feet in front of the paving machine. The loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphaltic concrete shall be picked up and loaded into the paving machine.

(C) Placing and Finishing Asphaltic Concrete by Means of Self-Propelled Paving Machines:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

In order to achieve, as far as practical, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective without tearing, shoving, or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as

to height and crown and shall be equipped with a controlled heating device for use when required.

Tapered sections not exceeding 8 feet in width, or widened sections not exceeding 4 feet in width may be placed and finished by other means approved by the Engineer.

(D) Automatically Actuated Control System:

Except under certain conditions or at certain locations where the Engineer deems the use of automatic controls impractical, asphaltic concrete shall be placed and finished by means of self-propelled paving machines equipped with an automatically actuated control system.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly, either through controlling the transverse slope or, alternately when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with the following devices which shall be furnished with the machine:

(1) Ski-type device at least 30 feet in length, supported throughout its entire length; and

(2) Short ski.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

407-7.05 Joints:

Longitudinal joints shall be staggered a minimum of 1 foot with relation to the longitudinal joint of the immediate underlying course.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

Longitudinal joints shall be located within 1 foot of the centerline between two adjacent lanes.

407-7.06 Compaction:

(A) General Requirements:

The temperature of the asphaltic concrete just prior to compaction shall be at least 200 degrees F (250 degrees F when PG TR+ asphalt cement is used).

(B) Equipment:

Compacting and smoothing shall be accomplished by the use of static steel wheel compactors. Vibrator compactors may be used in the static mode only. The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. A minimum of three compactors shall be provided; however, sufficient compactors shall be provided so that the drums of the compactors when staggered will cover the entire width of the paving machine during initial breakdown.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Compactors shall weigh not less than 8 tons.

(C) Rolling Procedure:

A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

Compaction shall consist of the following rolling sequence:

Rolling Sequence	Number of Coverages
Initial	1
Finish	1 – 2

A sufficient number of compactors shall be used for initial breakdown so that when the compactors are staggered the entire width of the mat being laid is compacted with one forward pass of the compactors. The distance between the paving machine and the initial rolling shall not exceed 200 feet.

A separate roller(s) shall be used for final compaction. The roller(s) used for final compaction shall follow as closely behind the initial breakdown rollers as possible.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified,

ballasted and operated in accordance with the manufacturer's recommendations and with the number of coverages of the compactors as specified.

407-7.07 Compacting Miscellaneous Items and Surfaces:

Asphaltic concrete used in the construction of miscellaneous items and surfaces shall be compacted using compactors, hot-hand tampers, smoothing irons, mechanical vibrating hand tampers, or with other devices to the extent considered necessary by the Engineer.

407-7.08 Smoothness and Surface Tolerances:

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13 of the specifications.

Regardless of whether testing in accordance with Subsection 109.13 of the specifications is specified or not, the following requirements shall be met:

(A) The finished asphaltic concrete surface shall be tested and shall not vary by more than 1/8 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints; and

(B) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

407-7.09 Acceptance:

Asphaltic concrete will be accepted complete in place if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no additional cost to the Department.

407-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, bituminous material, and mineral admixture. Measurement will include any weight used in construction of intersections, turnouts, miscellaneous items, or other surfaces.

407-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton, adjusted if necessary for spread, which price shall be full compensation for the work, complete in place, as specified herein.

If the quantity in a spread lot is found to vary by more than +5.0 percent from the required quantity, as determined in accordance with Subsection 407-6.04 of the specifications, no payment will be made for the material which exceeds the +5.0 percent, including asphalt cement and mineral admixture.

The Engineer may exclude asphaltic concrete from the spread lot if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

No separate measurement or payment will be made for asphalt cement, the cost being considered as included in the cost of the asphaltic concrete.

A reduction in payment to the contractor for asphaltic concrete will be made for quantities of asphalt cement that do not meet the requirements of Section 1005 as determined by corresponding test results. Adjustments in payment shall be made in accordance with the requirements of Section 1005 of the specifications.

No separate measurement or payment will be made for mineral admixture, the cost being considered as included in the cost of the asphaltic concrete.

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13 of the specifications.

When lime water is used, no separate payment will be made for the lime water or its application, the cost being considered as included in this contract item.

SECTION 408 COLD RECYCLING (BITUMINOUS SURFACE):

408-1 Description:

The work under this section shall consist of furnishing all materials and reclaiming (milling) a portion of the existing asphaltic concrete pavement, or utilizing stockpiled reclaimed asphalt pavement, sizing the material, and mixing the material with an engineered emulsion, water, and other additives as necessary and as required by the mix design, to produce a homogeneous recycled asphalt mixture which is placed and

compacted on the roadway. The work shall conform to the requirements of the project plans, and the specifications, and be accomplished by means of either in-place recycling or central plant recycling, or a combination of the two.

408-2 Cold Recycle Material:

Cold recycled material shall consist of a homogeneous blend of reclaimed asphalt pavement, corrective aggregate, engineered emulsion, water, mineral admixture, and other additives as required by the mix design.

Cold in-place recycled material shall consist of existing asphalt pavement that is reclaimed and processed in place.

Cold central plant recycled material shall consist of stockpiled reclaimed asphalt pavement that is processed offsite at a central plant.

Material that is not transported to a cold central recycling plant but is milled and placed in a windrow adjacent to the original location and subsequently screened, crushed, and mixed with an engineered emulsion and other additives prior to placement and compaction on the roadway is also identified as cold in-place recycled material under this specification. The unit weight, engineered emulsion percentage and mineral admixture percentage shall be as specified in the Special Provisions.

408-2.01 Reclaimed Asphalt Pavement (RAP):

The Reclaimed Asphalt Pavement, hereinafter referred to as RAP, shall consist of asphaltic concrete removed from the project roadway or previously stockpiled salvaged asphaltic concrete.

RAP shall not contain injurious material, clay balls, adhering films, pavement markers, loop detector wires, paving fabrics, vegetable matter, or excessive amounts of crack fill material, and/or cutback asphalt. RAP stockpiles shall be processed to be homogeneous and shall not include materials not accounted for in the mix design. Residual materials that cannot be sufficiently removed from the RAP may be included in the cold recycled material provided the contractor can demonstrate that incorporation of the residual materials will not adversely affect performance if dispersed evenly throughout the RAP and accounted for in the mix design.

RAP stockpiled for purposes of cold central plant recycling may be kept in a single stockpile, but shall be fractionated into two or more sizes if gradation consistency cannot be maintained during production. The lower 12 inches of stockpiled RAP shall not be incorporated into the cold recycled material. Cold central plant composite RAP production tolerances for percent passing the required sieves are provided in Table 408-1.

TABLE 408-1 COMPOSITE RAP GRADATION PRODUCTION TOLERANCES		
Sieve Size	**1 Inch Max. Aggregate**	**1-1/4 Inch Max. Aggregate**
3/4"	±10%	±15%
1/4"	±10%	±10%
No. 4	±8%	±8%
No. 40	±4%	±4%

RAP shall be reduced to 100-percent passing the sieve size specified in the Special Provisions prior to mixing in a traveling or central plant.

The Engineer will take verification samples of processed composite RAP material prior to its introduction into the cold central plant recycling process.

408-2.02 Recycling Additive:

Recycling additive shall include a mineral admixture of lime slurry and may include an additional mineral admixture of Portland cement and/or corrective aggregate to meet performance requirements or improve cold recycled material mix cohesion, aid in curing or early strength for opening to traffic, or provide resistance to moisture induced damage. The usage rate of all additives shall be determined by the mix design.

(A) Corrective Aggregate:

Corrective aggregate shall consist of either crushed virgin aggregate or fractionated existing RAP added to the RAP material to correct deficiencies in aggregate structure, stability, and/or performance criteria. Crushed virgin aggregate used as corrective aggregate shall meet the requirements of Subsection 416-3.01 of the specifications. The quantity of corrective aggregate shall be determined by the mix design.

(B) Lime Slurry:

Quicklime or hydrated lime shall meet the requirements of AASHTO M 216 or ASTM C977 and the quantity of lime included in the cold recycled material shall be determined by the mix design. The slurry shall have no less than 30 percent solids.

(C) Portland Cement:

Portland cement may be added in dry or slurry form to the cold recycled mixture. If added in slurry form, the slurry shall contain no less than 30 percent solids. Portland cement shall be Type I or II conforming to AASHTO M 85/ASTM C150 or AASHTO M 240/ASTM C595. The quantity of cement included in the cold recycled material shall be determined by the mix design.

408-2.03 Engineered Emulsion for Cold Recycling:

The emulsion used for cold recycling shall be a bituminous, solventless, engineered, emulsified asphalt conforming to Section 1005 and Table 408-2 of the specifications. The emulsion shall have been used successfully on at least two cold recycled projects in the Western United States.

A successful project is one with at least 10 lane miles of cold recycling processing, a minimum 10-year traffic loading of 300k ESALs, and the surface opened to traffic no later than the morning after processing without the development of rutting or raveling to the extent that a detour in traffic or repair was required. Any failure is cause to deny approval.

The performance grade of the residual asphalt binder for this project shall be grade specified in the Special Provisions.

TABLE 408-2
ENGINEERED EMULSION FOR COLD RECYCLING

Test On Emulsion (1)	**Test Method**	**Requirement**
Settlement: 5 days, % maximum (2)	AASHTO T 59	5
Sieve: Retained on No. 20, % maximum	AASHTO T 59 (3)	0.30
Particle Charge (4)	AASHTO T 59	Pass or Fail (5)
Residue from Distillation: % minimum	AASHTO T 59 (6)	63
Oil Distillate, Volume of Emulsion, % maximum	AASHTO T 59 (6)	1.0
Tests on Residue from Distillation:		
Dynamic Shear of Original Binder: G*/Sin δ, kPa, minimum	AASHTO T 315	1.00
Creep Stiffness of PAV Binder: S, MPa, maximum	AASHTO T 313 (7)	300
m-value at 60 sec., minimum	AASHTO T 313 (7)	0.300

Notes:

(1) Perform tests within 30 days from date delivered.

(2) Settlement test is required if the emulsion is not used within five days of production.

(3) Distilled water shall be used.

(4) Particle charge test is only required for cationic emulsions.

TABLE 408-2
ENGINEERED EMULSION FOR COLD RECYCLING

(5) If the particle charge test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

(6) The AASHTO T 59 standard procedure is used for emulsions without polymer. The AASHTO T 59 alternative requirements are used for emulsions with polymer. Maximum distillation temperature for polymer modified emulsions shall be 350 F.

(7) The residue shall be subjected to RTFO aging. If, following RTFO aging, the residue still lacks the stiffness necessary to complete testing at the appropriate test temperature from Table 1 of AASHTO M 320, the test temperature may be lowered in order to complete testing and the lower test temperature shall be reported on the mix design.

A Certificate of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for the engineered emulsion.

408-2.04 Water:

Water required for lime or cement slurry and to facilitate milling, mixing, coating, and compaction shall meet the requirements of Subsection 1006-2.02 of the specifications. The total amount of water to be added, adjusted for moisture in the existing pavement during production, shall be determined by the mix design.

408-2.05 Fog Coat:

The fog coat shall consist of the engineered emulsion, or a CRS emulsion compatible with the engineered emulsion used during recycling, meeting the requirements of Section 1005 of the specifications. Fog coat may be diluted up to 60 percent by volume with water.

408-3 Mix Designs:

The mix design(s) for cold recycled material shall be developed in a laboratory under the direction of a Professional Engineer experienced in such mix designs. A discussion of the characteristics of the in-place material to be recycled that includes the in-situ density and moisture content shall be discussed in the mix design.

Any existing material that will not be incorporated into the cold recycled material, as determined by the contractor, such as recent chip seals, cold mix patches or overlays, and crack fill material shall not be included in the material for the mix design. A list or table of areas of the existing road or portions of the existing stockpiled material requested to be excluded from cold recycling that are in addition to any such areas

identified in the plans shall be submitted to the Engineer. The Engineer will determine which, if any, of the requested areas of the roadway or portions of the existing stockpiles are to be excluded.

The mix design shall be developed in accordance with the Asphalt Recycling & Reclaiming Association's "Recommended Mix Design Guidelines for Cold Recycling Using Emulsified Asphalt Recycling Agent (CR201)" and on the basis of the following criteria and tested in accordance with the requirements of the associated test methods provided below in Table 408-3.

TABLE 408-3
COLD RECYCLING MIX DESIGN CRITERIA

Criteria	Requirements	Test Method
Engineered Emulsion Content, %, by dry weight of RAP and corrective aggregate	Report Only	
RAP Binder Content, % by dry weight of RAP	Report Only	ASTM D2172/ AASHTO T 164
Moisture Content, % by dry weight of RAP and corrective aggregate	1.5 to 3.0	AASHTO T 255
Lime, % dry additive by weight of dry RAP and corrective aggregate	0.5 to 1.5	
Portland cement, % dry additive by weight of dry RAP and corrective agg. (if used)	Report Only	
Dry Screened RAP Gradation	Maximum Top Size and Medium and Coarse Gradation (per Subsection 408-3.01)	AASHTO T 11/ T 27
Corrective Aggregate, %, by weight of dry RAP (if used)	Report Only	
Corrective Aggregate Gradation	Report Only	AASHTO T 11, T 27
Combined Gradation w/ & w/o admix	Report Only	AASHTO T 11, T 27
Engineered emulsion film thickness, micron	Report Only	Asphalt Institute Manual MS-2
RAP Binder PG	Report Only	AASHTO M 320
Bulk Specific Gravity of Gyratory Specimens (30 gyrations)	Report Only	AASHTO T 166

TABLE 408-3 COLD RECYCLING MIX DESIGN CRITERIA		
Criteria	**Requirements**	**Test Method**
Maximum Theoretical Specific Gravity	Report Only	AASHTO T 209
Air Voids of Compacted, Cured Specimens	8.0-15.0%	AASHTO T 269
Indirect Tensile Strength: psi, minimum (1)	45	AASHTO T 283
Tensile Strength Ratio: min.% (1)	60	AASHTO T 283
Raveling Test: % wear loss, maximum	7.0	ASTM D7196
RAP Coating Test: minimum	Good	AASHTO T 59, Section 29
Hamburg Wheel Tracker (2)	12.5 mm maximum at 5,000 passes	AASHTO T 324

Notes:

(1) Compact tensile strength ratio specimens to within 2% of the mix design air void target.

(2) Use 6 inch diameter 30-gyration compacted samples cured for 48 hours at 60 degrees C and tested at 50 degrees C for locations above 3,000 feet in elevation and tested at 56 degrees C for locations below 3,000 feet in elevation.

If ambient conditions are expected to exceed 85 degrees F during construction, high temperature validation of the mix design, as described in ARRA CR201, Chapter 4, shall be performed.

High calcium quicklime or hydrated lime shall be added to the cold recycled material in slurry form, at a rate of 0.5 to 1.5 percent by weight of dry rap and corrective aggregate.

If dry cement is included to meet performance requirements, the ratio of residual asphalt in the engineered emulsion to the weight of dry cement shall be at least 3.0:1.0. The cement shall be within the range of 0.0 to 1.0 percent by dry weight of RAP and corrective aggregate.

408-3.01 Mix Design for Cold In-Place Recycled Material:

A mix design, or mix designs, shall be developed by the contractor for each unique segment of roadway to be recycled, as identified on the plans. Cores shall be taken at a minimum frequency of 2,500 foot intervals and where a significant change in material exists, either visually or through examination and analysis of the cores. Additional cores shall be taken to locate the transition to within 500 feet or less.

A list or table of areas requested to be excluded from cold in-place recycled construction that are in addition to any such areas identified in the plans, shall be submitted to the Engineer. The Engineer will determine which, if any of the requested areas, are to be excluded.

Representative material of at least 350 pounds shall be obtained from each unique segment from within the widths and depths to be recycled either by taking additional cores or by milling. Material obtained shall be consistent with the intended paving plan so that mix designs are developed for the cold in-place recycling operations performed within each segment. Locations for coring/milling shall be determined by the contractor and will be approved by the Engineer. The maximum distance from beginning or end of the segment and sample locations, and spacing between subsequent sample locations shall be no more than 2,500 feet. If stripping is observed within any core, the Engineer shall be notified and allowed to observe the core and determine any additional coring necessary.

If coring, three cores shall be obtained from each location with approximately 15 percent of the cores taken from the shoulder (if the shoulder is included in the cold in-place recycling) and 25 percent from within 3 feet of the centerline. The remaining cores shall be split approximately evenly between vehicle wheel tracking paths and outside wheel tracking paths. If milling, material shall be representative of the widths to be recycled. Cores shall have a minimum diameter of 6 inches. The approximate location of transitions and average unit weight of cores representative of each unique segment shall be reported on the associated mix designs. Core holes shall be patched with a material approved by the Engineer.

A core and/or milling log including the date, station, milepost, offset, core thickness/mill depth, and mill width shall be provided to the mix design laboratory and be attached to the mix design. Any existing material that will not be included in cold recycling shall be trimmed from cores and discarded. Each core / sample of millings shall be identified to correspond with the log.

The material from each segment for which a mix design will be prepared shall be broken down with a laboratory milling machine or mechanical crusher and combined into a homogenous mixture representative of the segment. Both a medium and a coarse band mix design meeting the associated gradation band shown in the table below shall be developed with engineered emulsion for the material obtained from each unique segment of roadway. Artificial laboratory grading consisting of sieving and re-compositing RAP material may be required to achieve the indicated gradations.

Sieve Size	**Medium Gradation (% Pass)**	**Coarse Gradation (% Pass)**
1-1/4 Inches	100	100
3/4 Inches	93-97	83-87
# 4	48-52	38-42

# 30	8-12	3-7
# 200	1.0-3.0	0.5-2.0

408-3.02 Mix Design for Cold Central Plant Recycled Material:

For existing reclaimed asphalt pavement (RAP) already stockpiled, or RAP that will be reclaimed from within the existing project roadway, transported, and processed off site by cold central plant recycling, the mix design(s) shall be developed for the expected gradation during production. This determination shall be made by operating the plant in a manner consistent with that which will occur during production. The mix design for cold central plant recycled material shall meet the requirements of Table 408-3 in Subsection 408-3.01 of the specifications.

The source of any existing RAP, including location, depth, and original mix design information, if known, shall be provided to the Engineer. A new mix design shall be developed whenever there is a significant change in the source or properties of RAP, as determined by the Engineer.

408-4 Equipment:

The recycling equipment shall be capable of milling the existing roadway (for cold in-place recycling), sizing the milled and/or stockpiled RAP, and mixing the RAP with the engineered emulsion and any additives required by the mix design in a controlled process that produces a homogeneous and consistent cold recycled mixture meeting the requirements herein. The equipment shall be capable of removing/placing the material to the lines and grades shown on the plans.

408-4.01 Cold In-Place Recycling Train Requirements:

Cold in-place recycling trains shall be self-propelled multi-unit trains designed specifically for cold in-place pavement recycling with automatic grade control and be equipped with a planing unit, screening and crushing unit, and a dedicated mixing chamber. Cold in-place recycling trains shall be equipped with the necessary equipment to satisfactorily perform the work. The equipment shall be controlled electronically by a computerized central control unit receiving inputs from belt scales and flow meters to control the addition of the engineered emulsion, recycling additives, and water.

(A) Cold In-Place Recycling Train Equipment:

The primary milling equipment/cold planer shall have a minimum cutter width of 12.5 feet and be equipped with depth controls capable of maintaining the desired cutting depth to within 1/4 inch, and shall have effective means for controlling cross-slope. The milling equipment shall

not disturb underlying material. Use of a heating device to soften the existing pavement will not be permitted.

If corrective aggregate is required by the mix design, the primary cold planer shall be capable of capturing all corrective aggregate placed in a windrow ahead of the cold planer. The cold planer shall include extensions if road geometry and the approved cold in-place recycled material paving plan require such or a supplemental mill shall be used ahead of the primary cold planer. The operating mode of the primary cold planer shall be set to a down cutting mode unless a more desirable gradation is obtained by operation in an up cutting mode.

The addition of lime or cement slurry additive shall occur at the cutter head and be computer controlled and capable of automatic adjustments for working speed. The application system shall apply the slurry at a minimum tolerance of 0.1 percent of the required rate.

The screening/crushing unit shall adequately screen RAP exceeding the maximum size, crush oversized RAP, and reintroduced crushed RAP to the screen prior to mixing with the engineered emulsion. The screen must remain clear of buildup of unsuitable material such as crack fill or binder rich patch materials that might otherwise clog the screen.

A conveyor belt shall transfer the screened and crushed RAP and any recycling additive to the mixing chamber/pugmill where the combination of materials shall be thoroughly mixed with the engineered emulsion and additional mixing water. A calibrated belt scale/weigh bridge shall be located on the conveyor belt immediately prior to the mixing chamber.

An electronically controlled, computerized metering, and proportioning system shall monitor the weight of processed RAP (and additive) and control the addition of engineered emulsion. An independent source equipped with a flow meter shall be used to spray additional mixing water to disperse the engineered emulsion. The metering system shall be equipped with alarms should any part of the operation fall outside of tolerance. The system shall be capable of making automatic adjustments for fluctuations in the weight of processed RAP and additive entering the mixing chamber and controlling the addition of engineered emulsion to within 0.1 percent of the required rates. The rate of addition of mixing water shall be adjustable to compensate for fluctuations in existing pavement moisture or as the contractor determines necessary for production. Excessive additional mixing water will not be permitted.

If at any time the ability of the equipment or metering system to accurately monitor and control the production process is in question, the Engineer may halt further in-place operations until such time that the contractor has demonstrated that the equipment and metering system is functioning properly and producing acceptable material.

(B) Cold In-Place Recycling Train Calibration:

Prior to use on the project, the cold in-place recycling train shall be calibrated, or evidence of calibration within the previous 12 months shall be provided to the Engineer for review.

The calibration shall include the items listed below. Any changes in recycling equipment will require re-calibration. If calibration is necessary, the contractor shall provide certified platform scales at the calibration site. A copy of the certification shall be provided to the Engineer prior to calibration. The Engineer will observe the calibration and will approve if the calibration standards are met. The contractor shall record the results of the calibration and provide it to the Engineer prior to beginning recycling operations.

Aggregate Weigh Belt Scale:

1. Manufacturer, serial number, load cell type, and load rating of belt scale;

2. Manufacturer, model number, serial number of belt speed sensor;

3. Zero and span numbers for belt speed sensor (shall be within 5 percent of calibration);

4. Test weight in pounds (shall be at least 10 tons);

5. Calibrate at two different speeds;

6. Report the calculated tons per hour (TPH) based on test weight, belt length and belt speed;

7. Repeat at each production speed;

8. Verification that the masses shown on the console indicators for each run are both within 1.0 percent of each other and within 1.0 percent of the actual weight as weighed on the certified platform scales; and

9. Verification that the console indicators display both tons per hour and total tons of material processed.

Engineered Emulsion Metering Device:

1. Manufacturer, type (mass flow, positive displacement, turbine, other), size (pipe diameter), and serial number of the emulsion meter;

2. Calibration parameters (counts per gallon for digital, or pounds per minute for analog);

3. Pounds per gallon of product used during calibration;

4. Verification that the engineered emulsion was introduced into the mixer through a calibrated metering device at two different speeds;

5. Verification that the masses shown on the console indicators for each run are both within 1.0 percent of each other and within 1.0 percent of the actual weight as weighed on the certified platform scales; and

6. Verification that the pump is equipped with a ready means of varying the engineered emulsion delivery rate.

Slurry Metering Device:

1. Manufacturer, serial number, type (mass flow, magnetic, turbine, other), size (pipe diameter);

2. Calibration parameters (counts per gallon for digital, or pounds per minute for analog);

3. Verification that the slurry was introduced into the mill head using a mass-flow coriolis effect type meter at two different speeds;

4. Verification that the metering device is equipped with a ready means of varying the slurry delivery rate; and

5. Verification that the masses shown on the console indicators for each run are both within 1.0 percent of each other and within 5.0 percent of the actual weight as weighed on the certified platform scales.

The cold in-place recycling train shall be calibrated to the satisfaction of the Engineer. A known amount of aggregate shall be processed through the cold in-place recycling train. The cold in-place recycling train shall be fully operational and shall process the aggregate with any required engineered emulsion, recycling additive, and additional mixing water. The contractor shall provide a computer printout of the materials metered and controlled during the calibration process. The quantities on the printout will be compared to the actual quantity of materials used to determine the accuracy of the metering system.

The contractor shall demonstrate during the calibration that all components of the cold-recycling train are functioning properly. If reason exists to question the functionality, the Engineer may prevent in place operations until such time that the contractor has corrected any deficiencies and demonstrated an acceptable calibration.

After placing the first 1,000 feet of cold recycled material at the project site, the contractor shall stop production and verify that the quantities are within the target tolerances before placing additional cold recycled material. Verification shall include tank level measurements and gauge to meter comparisons. During operation, from 5 to 75 tons, the Department will verify that the digital display of the electronically controlled computer monitoring and proportioning system indicates that the required additions of all materials are as desired and maintained at acceptable tolerances.

408-4.02 Cold Central Plant Recycling Requirements:

Cold central plant recycling shall consist of using a stationary cold mix plant to produce cold recycled material.

The plant shall have a screening/crushing unit, the appropriate number of cold feed bins for corrective aggregate and fractionated RAP, conveyor belts with calibrated belt scales, an electronically controlled, computerized liquid additive system, a pugmill or drum mixer, and surge bins, storage silos, or the ability to store cold recycled material in stockpiles or discharge directly into haul vehicles. If no corrective aggregate or RAP fractionation is required, the plant may have a single cold feed bin/hopper.

Except for drying, heating, and temperature monitoring requirements, the plant shall meet the requirements of Section 403 of the specifications.

(A) Cold Central Plant Recycling Equipment:

The screening/crushing unit shall adequately screen RAP exceeding the maximum size. Excessively large RAP may be scalped and completely removed from the RAP material, or may be crushed and reintroduced to the screen.

A separate cold feed bin shall exist for each size of corrective aggregate and fractionated RAP as required by the mix design or to control gradation. If necessary, dividers shall exist to ensure that no RAP or corrective aggregate from a single bin spills over into an adjacent bin.

The plant shall transfer corrective aggregate and RAP to the pugmill or mixing drum with conveyor belts equipped with calibrated belt scales. The belt scales shall be linked to an electronically controlled, computerized liquid additive system that accurately meters the materials into the mixer based on the weight of the RAP. Liquids (emulsion, water, and additives in slurry form) shall be metered into the mixer using positive displacement pumps with interlocks to shut off the supply when the chamber is empty.

Storage of cold recycled material produced shall be such that the material is protected and does not become contaminated.

(B) Cold Central Plant Recycling Calibration:

Prior to use on the project, the cold central plant shall be calibrated, or evidence of calibration within the previous 12 months shall be provided to the Engineer for review.

The calibration shall include the items listed below. Any changes in recycling equipment will require re-calibration. If calibration is necessary, the contractor shall provide certified platform scales at the calibration site. A copy of the certification shall be provided to the Engineer prior to calibration. The Engineer will observe the calibration and will approve if the calibration standards are met. The contractor shall record the results of the calibration and provide it to the Engineer prior to beginning recycling operations.

Aggregate Weigh Belt:

1. Calibrate the aggregate weigh belt at the anticipated production speed;

2. At least 10 tons shall be used for the weigh belt calibration;

3. Calibrate the aggregate feed so the masses shown on the console indicators are within 1 percent of the actual mass as weighed on the certified platform scales; and

4. Display must have readings showing the tons per hour of the material and the total tons of material processed.

Engineered Emulsion Metering Device:

1. Introduce the engineered emulsion into the mixer through a calibrated metering device;

2. Equip the pump with a ready means of varying the emulsion delivery rate; and

3. Calibrate the feed using the percentage set in the approved mix design so the masses or gallons shown on the indicators are within 0.5 percent of the actual mass as weighed on the certified platform scales.

Slurry Metering Device:

1. Introduce the slurry into the mixing chamber using a Mass Flow Coriolis effect type meter;

2. Equip the metering device with a ready means of varying the slurry delivery rate; and

3. Calibrate the slurry feed using the percentage set in the approved mix design so the masses or gallons shown on the indicators are within 1 percent of the actual mass as weighed on the certified platform scales.

408-4.03 Haul Trucks:

Haul trucks for cold central plant recycled material shall have smooth, clean beds. Any asphalt release agents used shall be approved by the Engineer. Diesel fuel shall not be used as a release agent.

A sufficient number of haul trucks shall be provided to ensure delivery to the cold recycling operation within sufficient time to allow continuous and proper placement and compaction of the cold recycled material.

408-4.04 Mechanical Spreader:

If, in the judgement of the Engineer, a uniform windrow of corrective aggregate cannot be placed with haul trucks, a mechanical spreader shall be used to place corrective aggregate on the existing pavement surface in a uniform and controlled amount ahead of the cold in-place recycling train. Alternatively, a conventional paver may be used.

408-4.05 Slurry Mixing and Storage Tanks:

Lime or Portland cement slurry mixing and storage tanks shall be adequately sized to provide sufficient supply for the rate of cold recycled material production. Tanks shall have agitators for mixing and continued agitation during storage to keep solids in suspension.

408-4.06 Material Transfer Vehicle/Windrow Elevator:

The equipment used to transfer materials from the grade to the paver shall be capable of transferring all material from the grade to the paver hopper. The equipment used to transfer materials shall allow the paver to operate continuously, keeping the head of material in front of the screed constant by supplying a continuous amount of mix to the screed.

408-4.07 Paver Requirements:

Pavers may be either cold mix pavers or conventional asphalt pavers (operated without screed heating) capable of adjusting the placed thickness and width of cold recycled material. Pavers for placement of cold recycled material may be either attached to the cold in-place recycling train or detached. Screed augers shall be of sufficient size to fully fill the screed and screed extensions without causing segregation within the cold recycled material. The paver hoppers shall be appropriately sized to accommodate changes in pavement section, thickness, and/or width.

408-4.08 Compaction Roller Requirements:

Both double steel drum vibratory and large sized pneumatic-tired rollers shall be used for compaction of cold recycled material. Double drum vibratory rollers shall weigh at least 10 tons; pneumatic rollers shall weigh at least 25 tons. The contractor shall have a certified weight ticket available for verification of actual weight upon request by the Engineer. The tire pressure of pneumatic-tired rollers shall be 90 ± 5 pounds per square inch unless otherwise specified by the manufacturer.

A sufficient number of pneumatic-tired rollers and double drum vibratory rollers shall be utilized to adequately compact the cold recycled material based on the rate of cold recycling production and paving speed.

Rollers shall be at least 5.5 feet in width or sized to prevent uneven overlap of subsequent passes and have properly functioning water spray systems to prevent pickup. Additional smaller size rollers may be utilized if approved by the Engineer.

408-4.09 Water Truck:

A water truck shall be used to supply water to the milling equipment during cold in-place recycling operations. The water truck system shall be capable of supplying the mixing chamber with an independent source of water meeting the requirements of Subsection 408-2.04 of the specifications.

408-4.10 Fog Sealing and Blotter Sand Spreading Equipment:

A certified distributor truck capable of spreading emulsified asphalt at a uniform rate over the full width of the traffic lane in a single application shall be utilized for fog sealing. No traffic will be allowed on surfaces receiving a fog seal until the emulsion has broken and cured sufficiently. Blotter sand meeting the requirements of Section 404 of the specifications shall be applied, if necessary.

408-5 Just-in-Time Training:

At least 10 working days prior to cold recycling operations, the contractor shall provide Just-in-Time Training for cold recycling construction and related operations to contractor and Department personnel. The training shall be presented by a firm or an individual experienced in cold recycling acceptable to the Engineer. The training shall cover the following topics:

(1) Safety & Communication;

(2) Ambient / Weather Conditions & Requirements;

(3) Pavement Conditions;

(4) Traffic Conditions & Traffic Control;

(5) Pavement Preparation & Spreading of Recycling Additive (if utilized);

(6) Milling Equipment, Settings, Supplemental Milling;

(7) Cold In-Place Recycling Train Operations (if utilized);

(8) Cold Central Plant Recycling Operations (if utilized);

(9) Introduction of Lime/Cement Slurry and additional Water;

(10) Slurry / Water Control Settings / Flow Gauges;

(11) RAP Screening and Oversize RAP Crushing;

(12) Corrective Aggregate (if utilized);

(13) Introduction of Emulsion, Emulsion Control, Flow Gauges & Mixing;

(14) Emulsion Control Settings / Flow Gauges;

(15) Computer Controls & Alert Systems;

(16) Calibration, Test Strip & Optimizing Emulsion Rate based on In-Place Density);

(17) On-the-fly Quantities Checks / Calculations;

(18) Verifying Adequately Coated Cold Recycled Material;

(19) QC Sampling & Testing;

(20) Emulsion and Corrective Aggregate Adjustments & Mix Design Transitions;

(21) Paving Equipment;

(22) Curing Period;

(23) Compaction Equipment, Timing, and Process;

(24) Acceptance Sampling & Testing;

(25) Identifying & Wasting Suspect Materials;

(26) Identifying / Preventing Instability;

(27) Fog Coat, Blotter & Opening to Traffic;

(28) Secondary Compaction; and

(29) Repairs & Overlay.

408-6 Pre-Cold Recycling Meeting:

At least one week prior to cold recycling operations, the contractor shall conduct a pre-cold recycling meeting with all contractor and Department personnel involved in the cold recycling process to discuss the requirements herein and the following:

(A) Project and site conditions expected to affect the cold recycling process;

(B) Project schedule;

(C) Delivery and hauling of materials;

(D) Equipment to be used;

(E) Computerized monitoring/metering systems;

(F) Potential issues with the existing asphaltic concrete;

(G) Necessary road preparation;

(H) Weather forecasts;

(I) General cold recycling operations; and

(J) Safety, quality control, traffic control, and any other issues pertinent to the cold recycling operation.

408-6.01 Cold Recycling Operations Plan:

An illustrated cold recycling operations plan shall be submitted to the Engineer which indicates:

(A) Locations, direction, and expected length and quantity of production for each day's operations;

(B) Locations at which depth and grade adjustments are necessary;

(C) Locations from which existing pavement will not be incorporated into the cold recycled material;

(D) Locations which are to be avoided;

(E) Locations at which mix design transitions are expected; and

(F) Any other information affecting the cold recycling operation.

Any updates shall be submitted to the Engineer at each weekly meeting.

408-6.02 Cold Recycling Quality Control Submittal:

A cold recycling quality control submittal shall be provided to the Engineer which identifies:

(A) Contractor personnel charged with performing quality control sampling, testing, and inspection, including experience, qualifications, and/or certifications. Personnel experience pertaining to cold recycling shall also be included; and

(B) The means by which the need for adjustments in recycling additive or additional mixing water, or transition to a different mix design will be determined.

Specific quality control requirements are provided in Subsection 408-9 of the specifications.

408-7 Construction Requirements:

Cold recycling construction shall be performed in accordance with the requirements herein. Throughout the cold recycling operation, adjustments may be made to the process including rates at which the engineered emulsion, recycling additives, and water are incorporated into the cold recycled material. However, such changes shall be made judiciously and only by experienced personnel based on substantive information verified by quality control, or pre-construction investigation. All changes and adjustments shall be reported to the Engineer.

At the conclusion of each day's operations, and prior to subsequent processing or placement of cold recycled material, a Daily Production Report which provides the quantities of all materials used and associated rates shall be provided to the Engineer.

408-7.01 Pre-Construction Investigation:

In addition to coring and milling performed for the mix design, the contractor may take additional cores or perform additional milling to aid in making adjustments to the cold recycling process during construction. Any such work shall include proper traffic control, safety precautions,

and patching the pavement where material is removed. The contractor shall request such investigation and include details of where and how material will be obtained and patched. The request shall be submitted to the Engineer for approval.

408-7.02 Road Preparation:

Prior to cold recycling operations, the contractor shall (1) identify and repair areas of insufficient support including subgrade and base course, as approved by the Engineer; (2) perform necessary valve and manhole cover/collar and utility installation adjustments; (3) mark areas containing objectionable material and excessive crack filling material to be excluded from the RAP, (4) locate utilities and mark other areas that must be avoided, (5) perform any required pre-milling for grade control, cross slope, or profile corrections, and removal of unsuitable materials, (6) identify by station the boundaries of materials which require different mix designs, adjustments to emulsion content, or corrective aggregate, and (7) clean all dirt, mud, vegetation, standing water, combustible materials, oils, raised or recessed pavement markers, and any other objectionable material from the roadway by means of sweeping, vacuuming, blading, or other acceptable means. This includes excess water accumulating on the surface or in the milled trench due to over application or leaking equipment.

These activities may be conducted concurrently with the cold recycling operation provided they do not interfere with cold recycling operations. If in the opinion of the Engineer, such work will be in conflict with or negatively affect or be affected by the cold recycling operation, the Engineer may stop cold recycling operations until conflicts and/or negative impacts can be avoided.

408-7.03 Application of Recycling Additive:

Lime, and, when required, corrective aggregate and/or Portland cement shall be introduced at the rates and amounts required by the mix design and in accordance with the requirements herein.

(A) Application of Corrective Aggregate:

For cold in-place recycling, imported fractionated RAP or virgin crushed aggregate shall be spread in a uniform and consistent manner (windrow or ribbon) ahead of the cold planer using belly dumps, a mechanical spreader, or a conventional paver. A blade shall be used, if necessary, to correct deficiencies, excesses, or inconsistencies in placement. The area over which each load of known weight of corrective aggregate is placed shall be determined and the application rate calculated, estimated by unit weight of existing pavement. The application rate shall be within 5 percent of the rate required by the mix design.

When a conventional paver is used for placement of corrective aggregate delivered by belly dumps, a pickup vehicle as described in Subsection

4.06 of the specifications capable of capturing all of the corrective aggregate shall be used to transfer the corrective aggregate to the paver hopper.

For cold central plant recycling, corrective aggregate shall be introduced from a cold feed bin calibrated for the correct application rate.

(B) Application of Dry Mineral Admixture:

Portland cement placed as a dry additive for cold in-place recycling shall be placed on the existing asphalt pavement surface ahead of the milling operation. The cement shall be placed in a windrow and the distribution controlled volumetrically with a known weight of material in each load. The application rate shall be verified using a drop pan or canvas patch of known dimension, and the material captured weighed. Application rates shall be within 0.1 percent of the rate required by the mix design, as measured by this method.

Dust control measures for Portland cement placed on the existing pavement, whether necessary due to wind or adjacent traffic, may include limiting the distance between the spreader and cold in-place recycling train, pre-wetting the road surface, or other means acceptable to the Engineer. If dust cannot be controlled, any required mineral admixture shall be added in slurry form or operations shall be suspended until conditions improve.

No traffic or construction equipment shall pass over spread additive.

For cold central plant recycling, dry cement or lime shall be added to the pugmill via silo auger or separate device with a calibrated belt scale. If a drum mixer is used, the additives shall be combined with the RAP/corrective aggregate using a pugmill mixer prior to the drum. Sufficient moisture shall be present in the RAP/corrective aggregate to prevent loss of additive during mixing.

For cold in-place recycling or mixing with a cold mix plant, the addition of lime or Portland cement shall be metered by the electronically controlled, computerized system such that the weight of additive as a percent of the weight of RAP and corrective aggregate is controlled to within 0.1 percent of the target rate and displayed digitally.

(C) Addition of Slurry:

Recycling additive added as slurry may be produced either by portable batching equipment or processed inline and fed directly to the cold in-place recycling mixing chamber. Slurry may be added directly to the mixing chamber in both cold in-place recycling and cold central plant recycling, or sprayed over the cutting teeth of the cold planer in cold in-place recycling. Slurry shall be produced at the jobsite or central plant with control of the solids and liquids proportioning. The application of slurry shall be controlled by mass or volume meters to ensure correct

application rates. The consumption of cement or lime and water shall be obtained from the computer that controls the slurry mixing unit. For cold in-place recycling, a volumetric distribution check shall be performed to ensure that the area cold recycled for each batch of slurry contains the amount of recycling additive required by the mix design and also to verify that control exists for application of the slurry. Slurry shall be applied such that the rate of additive is within 0.2 percent of the rate required by the mix design.

For lime slurry, chemical or quick lime shall be reacted with water to form hydrated lime slurry. The amount of lime and water added to each batch shall be known. When necessary, the slurry shall be allowed to cool sufficiently prior to addition to the cold recycled material to prevent adversely affecting the break time of the emulsion.

Slurry shall be kept in suspension during storage and transport with agitators or similar equipment.

408-7.04 Addition of Engineered Emulsion:

The engineered emulsion shall be of proper temperature and viscosity prior to injecting into the mixing chamber. The addition of the engineered emulsion shall be metered by the weight of the RAP and corrective aggregate with a calibrated meter capable of metering the amount of engineered emulsion to within 0.1 percent of the target rate. The metering device shall be capable of automatically adjusting the flow of the engineered emulsion to compensate for any variation in the weight of RAP and corrective aggregate introduced into the mixing apparatus.

408-7.05 Addition of Water:

For cold in-place recycling, additional water for dispersion of the engineered emulsion and compaction may be added either at the cutting head of the cold planer or in the mixing chamber. If modification to the application rate of the engineered emulsion occurs, the addition of water shall be adjusted accordingly to ensure that the total fluids injected remains consistent with the mix design. For water added in the mixing chamber, the mixing apparatus shall have an independent source of water to adequately disperse the engineered emulsion and/or introduce water to aid in compaction, also metered to within 0.1 percent of the target rate.

408-7.06 Metering and Proportioning:

The electronically controlled, computerized monitoring system shall display digital readings for the combined processing rate of RAP and corrective aggregate, addition rates for engineered emulsion, recycling additive, and water, the controls for which, shall be used to make adjustments during production. The system controlling the addition of engineered emulsion and additional mixing water shall be based entirely on the weight of RAP and corrective aggregate and any offsets entered

for existing moisture in the pavement/RAP. The system controlling the addition of slurry for cold in-place recycling shall be based on the widths and depths being recycled, unit weight of the pavement, weight of corrective aggregate, and forward speed of the cold in-place recycling train.

408-7.07 Processing and Placement:

The RAP shall be crushed and sized to the maximum particle size or fractionated and blended with the required amount of recycling additives, engineered emulsion, and water to facilitate both adequate dispersion of the engineered emulsion and compaction, to produce cold recycled material consistent with and meeting the requirements of the mix design. The mixture produced shall be a homogeneous recycled mixture and shall exit from the mixing chamber in a manner that prevents particle segregation.

During cold recycling operations, the equipment shall be operating as intended; any alarms or displays that indicate production is not occurring in accordance with the production targets will result in an immediate stop to production until the contractor has made necessary corrections/repairs.

Raised or recessed pavement markers, loop detector wires, excessive amounts of rubberized crack fill and other materials not intended for inclusion in the cold recycling material should be removed from the roadway and/or RAP stockpiles either prior to cold recycling operations or as observed during the recycling or fractionating process. Any residual materials included in the cold recycled mixture shall be appropriately sized and blended, as allowed by the mix design, to not adversely affect the appearance or performance of the recycled pavement.

The recycled mixture shall be spread using a screed to the design widths and elevations/thicknesses without the occurrence of segregation, tearing, or scarring, and handwork shall be minimized.

At no time shall processed or delivered recycled material placed on grade extend a distance ahead of the paver such that the emulsion begins to break prior to placement with the paver screed.

Any deleterious material in the paved cold recycled material shall be removed and the area repaired with additional cold recycled material.

If during production the contractor desires to adjust the engineered emulsion target by more than 0.3 percent, or the corrective aggregate target by more than 10 percent, in order to produce acceptable cold recycled material, the contractor shall notify the Engineer and obtain representative samples from production at the adjusted rate(s). Laboratory testing shall be performed by the contractor to verify that the adjusted targets result in cold recycled material satisfying the criteria in

Table 408-3. If test results are not satisfactory, a new mix design shall be prepared to determine the appropriate targets for the prevailing material. Any placed material deemed by the Engineer to be inadequate shall be re-recycled at the discretion of the Engineer.

(A) Cold In-Place Recycling:

For cold in-place recycling, the existing asphalt pavement, except for areas designated for exclusion, shall be cold milled to the length, depth, and width shown on the plans. There shall be no gaps of unrecycled pavement between successive/adjacent cuts with the cold planer. Longitudinal joints between successive/adjacent cuts shall overlap a minimum of 3 inches and not exceed 6 inches. Transverse joints shall overlap a minimum of 2 feet and not exceed 4 feet.

When corrective aggregate is utilized, such material shall be placed uniformly on the existing road surface ahead of the cold recycling train.

When paving fabric or other geosynthetics are encountered during the cold milling operation, the necessary changes in equipment or operations shall be made to either incorporate adequately shredded material into the cold recycled material, if allowed by the mix design, or completely remove such material. If allowed, any oversize pieces shall be removed. If during production the contractor identifies material, not previously identified, which should be discarded, the contractor shall provide the extent of such material to the Engineer. If in the opinion of the Engineer the material should be removed, such areas shall receive material meeting the requirements of Section 409, 416, or 417 of the specifications, as determined by the Engineer, paid for at the applicable bid item price.

Any fillet of fine aggregate material, which forms adjacent to a vertical face, shall either be removed from the trench prior to the spreading of the bituminous mixture, or dispersed to the center of the trench to the satisfaction of the Engineer. The dispersing of the fine aggregate material shall be accomplished with a power broom attached to the milling machine prior to the introduction of the bituminous mixture onto the roadway.

(B) Cold Central Plant Recycling:

For cold central plant recycling, the RAP shall be fractionated into a sufficient number of stockpiles to facilitate production of a consistent mixture when blended with recycling additives, engineered emulsion, and water, as required by the mix design.

The bottom 12 inches of material in each RAP stockpile shall not be incorporated into the cold recycled material and tracking over RAP with loading equipment shall be minimized. RAP stockpiles shall be protected from contamination and RAP shall be placed into cold feed bins such that spillage into adjacent bins does not occur.

Dispensing of cold recycling material into haul vehicles, transporting the material to the project, placement of the material on grade or in the paver hopper, and paving operations shall be such that segregation within the cold recycled material does not occur.

408-7.08 Compaction

The time at which compaction may begin after the recycled material has been placed is dependent on the engineered emulsion used, recycling additives, and ambient conditions. Compaction shall not begin until the recycled mixture begins to break which may be 30 minutes to 2 hours or more, after the material has been placed.

Rolling patterns shall be such that starting and stopping occurs on previously compacted material or the adjacent existing surface. At no time shall rollers stop or start on uncompacted recycled surfaces.

Breakdown and intermediate compaction shall be accomplished by a combination of steel drum vibratory rollers and pneumatic tire rollers. The rolling pattern shall be selected by the contractor and continuously monitored and adjusted by the contractor at approximately 500 ton intervals such that the maximum density and required smoothness are achieved. The rolling pattern shall be such that no further increase in density is achieved with additional passes, and cracking of the cold recycled material due to over rolling does not occur.

The in-place flow test performed in accordance with Arizona Test Method 430 may be used as an indicator to determine if the maximum achievable density is attainable.

Water should be uniformly applied to the wheels and drums of rollers, at the minimum rate necessary, along with necessary mechanical means, to prevent recycled material from being picked up. Any pickup shall be immediately removed from the wheels/drums by necessary means and any damaged/scarred areas of cold recycled material repaired and compacted. Pooling or ponding water on the recycled surface due to excessive spraying or any other reason will not be permitted. Any such areas of standing/excessive water shall be swept/dried as necessary.

As described in Subsection 408-9 of the specifications, field compacted specimens shall be prepared from processed cold recycled material obtained immediately in front of the compaction operation. The specimens shall be compacted in a 6-inch proctor mold in accordance with AASHTO T 272 except that no screening of the material is required before compaction. Compaction of the cold recycled material shall be monitored during the rolling operation with a thin lift nuclear density gauge in accordance with AASHTO T 355. The wet density determined at each location shall be recorded. Wet density determined by the thin lift nuclear density gauge measurements shall be compared to the wet density of the field compacted specimens. The dry density from nuclear density testing, calculated by removing the measured moisture content, as determined by AASHTO T 255, from the wet density, shall be

compared to the maximum theoretical density provided in the mix design to determine air void content and consistency with the mix design. The wet density of the placed cold recycled material shall be at least 98 percent of the average wet density of the associated field compacted specimens as identified in Subsection 408-10.02 of the specifications.

408-7.09 Fog Sealing and Blotter Material Application:

Fog coat and blotter material application shall be in accordance with Section 404 of the specifications. A fog coat shall be applied at a rate proposed by the contractor and approved by the Engineer.

The operation shall be such that the roadway can be returned to traffic within two hours from the end of cold recycle operations, or as required by the Engineer.

408-7.10 Opening to Traffic:

Prior to opening to traffic, the compacted cold recycled material shall be verified to be of adequate strength under the observation of the Engineer. The results of shear vane testing performed in accordance with Arizona Test Method 429 shall be at least 35 foot-pounds of torque and the results of in-place flow testing performed in accordance with Arizona Test Method 430 shall be such that the depression is no greater than 10 millimeters and the height of lateral deformation shall be no greater than 5 millimeters, without bleeding.

408-7.11 Maintenance:

The surface of the recycled pavement shall be maintained in a condition suitable for the safe accommodation of traffic. Any loose aggregate that develops on the surface of the recycled pavement shall be removed by power brooming. Any potholes that develop in areas the Engineer has deemed to be acceptable shall be filled with hot or warm mix asphalt and compacted.

Any work necessary to maintain the placed and compacted cold recycled material is considered included to cold recycling.

408-7.12 Curing:

Cure time will depend on the amount and type of engineered emulsion used, additional mixing water, recycling additive, and ambient conditions. Sufficient cure is when the moisture content of the cold recycled material is no more than 2.0 percent. The minimum cure time is 3 consecutive days without precipitation. The moisture content of the cold recycled material shall meet the requirements of Subsection 408-10.02 of the specifications prior to placing the final surfacing and/or overlay.

408-7.13 Secondary Compaction:

If, in the opinion of the Engineer, adequate compaction was not attained during placement and initial compaction, secondary compaction shall be performed after sufficient cure has been achieved and prior to the final surfacing or subsequent overlay. Secondary compaction shall consist of additional rolling with both pneumatic-tired and steel double drum rollers in static mode only. Secondary compaction shall only be performed when the pavement temperature is at least 80 degrees F.

A rolling pattern shall be established with a nuclear thin lift asphalt density gauge. The rolling pattern is the number of passes at which peak density is reached and the requirements of Subsection 408-7.08 of the specifications have been met. If no increase in density is realized or the cold recycled mat exhibits cracking, secondary compaction should be immediately suspended or foregone, as approved by the Engineer. Care shall be taken to ensure that the mat is not over rolled.

In the event that the requirements of Subsection 408-7.08 of the specifications are unattainable, the contractor shall consult with the mix designer, emulsion supplier, and quality control supervisor to investigate and determine a potential cause(s) for the failure to meet these requirements. The contractor shall provide an explanation to the Engineer including discussion of the expected performance of the material and if the material should remain in place, be re-recycled, or removed and replaced with dense graded asphaltic concrete.

408-7.14 Preparation for Surface Treatment:

Prior to placement of any required overlay or surface treatment, the completed cold recycled material shall be swept clean of all dirt, debris, loose material, and standing water. If an asphalt overlay is required, tack coat shall consist of emulsified asphalt meeting the requirements of Section 1005 of the specifications; a hot asphalt cement tack coat shall not be used.

408-7.15 Placement Dates and Weather Requirements:

Cold recycling operations shall only occur during daylight hours and between the dates shown below for the average elevation of the project and only when the pavement/RAP temperature is a minimum of 55 degrees F, or as required by the engineered emulsion manufacturer, whichever is greater. Ambient temperature in the shade at the beginning of placement shall be at least 50 degrees F and rising. Cold recycling operations shall cease when the ambient temperature is 60 degrees F and falling. Cold recycling operations shall not be performed when ambient temperatures are expected to drop to below 35 degrees F or exceed 95 degrees F within a 48-hour period after placement.

Cold in-place operations shall not begin and will not be allowed to continue when precipitation is expected or forecast to begin within four hours of cold recycling operations.

If cold recycled mat temperatures are expected to or do exceed 85 degrees F, high temperature verification of the mixture shall be performed. If at any time pavement temperatures are expected to or do exceed 160 degrees F, cold recycling operations shall cease immediately. Traffic will not be permitted on cold recycled material having a surface temperature of over 160 degrees F if, in the opinion of the Engineer, there exists the potential for instability. The contractor shall maintain a schedule which allows for overlay or chip seal placement within the allowable temperatures of the desired surface course.

The pavement/RAP and ambient temperature requirements may be adjusted by the Engineer provided the engineered emulsion supplier indicates that such adjustment is acceptable and compatible with the specific emulsion supplied to the project.

Average Elevation of Project, Feet	Beginning and Ending Dates
0 – 3499	March 1 – November 30
3500 – 4999	April 1 – October 31
5000 and over	May 1 – September 30

If, in the opinion of the Engineer, extended weather forecasts show conditions which are conducive to commencement of cold recycling operations, cold recycling operations may proceed.

408-8 Test Strip:

The first day of production for each mix design shall include a test strip with production of at least 1,500 feet but sufficient in size to evaluate and approve the equipment, construction process, workmanship, quality control, and verify that the equipment, materials, and processes proposed meet the requirements of the specification and result in a stable and durable pavement. All quantities of materials used, addition rates, and the metering and proportioning systems shall be verified to be accurate and within the required tolerances. Should evaluation of the test strip or verification of the metering and proportioning systems not be to the satisfaction of the Engineer, no further cold recycling operations shall occur until the contractor has made necessary corrections and adjustments, at which time, an additional test strip shall be performed.

The test strip shall be performed on mainline where prevailing pavement conditions exist that are representative of the majority of the area to be recycled. During construction of the test strip, the engineered emulsion shall be added at the target rate shown in the mix design and the appropriate rolling pattern, as discussed in Subsection 408-7.04 of the specifications, shall be established. Once established, the rate of engineered emulsion may be incrementally adjusted by 0.1 percent, but within ± 0.3 percent of the target rate on the mix design, as determined necessary by the contractor. A new rolling pattern shall be established following any change in the emulsion target rate.

Sampling and testing during placement and compaction of the test strip shall be as outlined in Section 408-9 of the specifications. The wet density of the placed cold recycled material shall be at least 98 percent of the average wet density of the field compacted specimens. If a minimum of 98 percent compaction is not achieved, the contractor shall make necessary adjustments and an additional test strip shall be constructed.

Once completed, traffic control shall be adjusted to allow traffic on the test strip and the area shall be periodically monitored to identify inadequate stability or raveling of the cold recycled material caused by apparent excess or deficiency in residual binder content.

Failure of the cold recycled material to perform will require re-recycling of the test strip or replacement with dense graded asphaltic concrete, as determined by the Engineer, adjustments to the existing mix design or a new mix design, and construction of an additional test strip.

408-9 Quality Control and Production Documentation:

The contractor shall perform the quality control measures described in Subsection 106.04(C) of the specifications. At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed:

(A) Aggregate production, including crusher methods, pit extraction, and washing for corrective aggregate;

(B) RAP production, including milling, crushing, screening, and handling methods;

(C) Stockpile management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention;

(D) Proportioning and plant control, including plant scale calibration, storing method, and addition of admixture;

(E) Transporting and placing, including hauling distance, segregation and non-uniform placement control, and joint placement and technique; and

(F) Compaction, including types and weight of rollers, establishing and monitoring of roller patterns.

Quality control and production documentation shall be comprehensive and performed on a continuous basis throughout the cold recycling operation with both periodic verification of quantities and rates and of total daily production or fraction thereof if a significant change in production occurs. A qualified technician, qualified testing laboratory, calibrated field testing equipment, and additional personnel, as

necessary, shall ensure that operations and material produced meet the requirements herein. All observations, measurements, adjustments, and corrective actions required to ensure compliance with mix design and specifications shall be documented. Quality control shall be performed in accordance with Subsection 408-9.01 of the specifications and production documentation shall be performed in accordance with Subsection 408-9.02 of the specifications.

408-9.01 Contractor Quality Control:

The contractor shall provide quality control to the extent necessary to determine the properties of the RAP, processed cold recycled material, and compacted cold recycled material to ensure conformance of the cold recycled material with the associated mix design and requirements herein. Minimum sampling and testing requirements are shown below:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	**TEST METHOD**	**SAMPLING POINT**	**MINIMUM TESTING FREQUENCY**
Maximum Aggregate Size	Determine with Appropriate Sieve	At central plant discharge or recycling train windrow	One per 1,000 ft.
Gradation	Arizona Test Method 240 (1)	At central plant discharge or recycling train windrow	Two per each day of production or change in material
Film Thickness	Asphalt Institute MS-2	At central plant discharge or recycling train windrow	Two per each day of production or change in material
RAP Temperature	Probe measurement or IR gun	Ahead of the recycling train or RAP stockpile	At start of production and every two hours
Moisture Content (4)	AASHTO T 255	At central plant discharge or recycling train windrow	One per 1,000 ft.
Field Compacted Specimens (4)	AASHTO T 272 (2)	After Paver Prior to Compaction	One per 1,000 ft.
Compaction (4)	AASHTO T 355 (3)	After Compaction	One per 1,000 ft. (5)
Shear Vane Test	Arizona Test Method 429	After Compaction	Prior to Opening to Traffic

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
Flow Test	Arizona Test Method 430	After Compaction	Prior to Opening to Traffic
Mat Moisture Content	AASHTO T 255	After curing prior to overlay	One per 2,500 ft.

Notes:

(1) Samples for cold in-place recycling shall be obtained to represent production at the low and high RAP temperatures.

(2) Field compacted specimens shall be compacted in a 6-inch mold in accordance with Arizona Test Method 241 except that no screening of the material is required.

(3) Compaction testing shall be performed with a thin lift nuclear density gauge. Wet density shall be recorded.

(4) The wet density of the thin lift nuclear density gauge tests shall be compared to the wet density of the associated field compacted specimens. The dry density from the nuclear density gauge, calculated by removing the measured moisture content, as determined by AASHTO T 255, from the wet density, shall be compared to the maximum theoretical density provided in the mix design, and the in-place air voids determined.

(5) A compaction test shall be performed which coincides with the location of each field compacted specimen. Compaction tests shall also be performed for any secondary compaction.

For the purposes of target rate selection as required in Subsections 408-7.03, 408-7.04, and 408-7.05 of the specifications, sampling ahead of the mill head may be necessary to determine the in-situ moisture content and unit weight of existing asphaltic concrete pavement. Samples of stockpiled RAP may also be necessary for cold central plant recycling.

Quality control personnel shall ensure that areas which are designated for exclusion from the cold recycling operation are not milled and do not become incorporated into the cold recycled material. Any debris or materials not accounted for in the mix design shall be identified and brought to the attention of the Engineer.

Recycling additive(s), engineered emulsion, and additional mixing water weights and rates, and the dry density of field compacted specimens shall be compared to the mix design to verify consistency with the mix design.

If at any time the calculated rates do not reasonably compare to those determined by the computerized metering and proportioning system, action shall be taken to correct or ensure that the system is accurately monitoring and metering the cold recycling operation. If the metering

and control systems are determined to be unable to accurately monitor and control the cold recycling operation, cold recycling operations shall cease immediately until such systems have been demonstrated to operate to the satisfaction of the Engineer.

408-9.02 Cold Recycling Production Documentation:

During cold recycling operations, the contractor shall document satisfaction of the Contractor Quality Control requirements and Quality Control Plan, and submit evidence of such to the Engineer weekly, to be included in the Weekly Quality Control Reports as required in Subsection 106.04(C)(6) of the specifications. The evidence shall consist of samples taken, tests performed, and associated test results, inspections, all verification calculations, Daily Production Reports, and any observations or actions taken pertinent to the cold recycling operation. Failure to include such documentation in the Weekly Quality Control Report will result in the associated report not being accepted. The Daily Production Report shall include documentation of the following:

(A) The existing road surface shall be verified to have been adequately prepared prior to cold planing/milling. The areas consisting of material designated for exclusion from the cold recycled material and any additional areas for which, exclusion is determined to be necessary, shall be identified and clearly marked on the pavement surface. Areas where excessively deteriorated pavement, unstable pavement, base, or subgrade conditions become apparent, which were not identified and repaired prior to the cold recycling operation, shall be documented and immediately brought to the attention of the Engineer;

(B) The placement and spreading of dry recycled additive (corrective aggregate and/or cement) shall be monitored, measured, and confirmed to be in accordance with the mix design and specification requirements;

(C) The cold planer and operation mode shall be verified to be operating properly and maintaining the required depth and width to within the required tolerances;

(D) Locations where excessive buildup occurred requiring cleaning of the screens;

(E) For cold in-place recycling, the weight of RAP and corrective aggregate processed through the cold in-place recycling train shall be calculated based on delivery weights of corrective aggregate, unit weight of existing pavement, and volume based on the dimensions milled. This weight shall be compared to the weight of material measured by the computerized metering and proportion system on board the

cold in-place recycling train minus any recycling additive and water added to the material;

(F) The weight of lime or Portland cement recycling additive measured by the computerized metering and proportioning system shall be compared to the weight of recycling additive dispensed by the holding tank or supply vehicle. If added in slurry form, the percent solids determined by the computerized metering and proportioning system shall be compared to the percent solids based on the weight of water and weight of lime used to produce the slurry;

(G) The temperature and appearance of the engineered emulsion shall be verified to be acceptable prior to the start of each day's cold recycling operations. The quantity of engineered emulsion measured by the computerized metering and proportioning system shall be compared to the quantity of engineered emulsion dispensed by the holding tank or supply vehicle;

(H) The quantity of additional mixing water measured by the computerized metering and proportioning system shall be compared to the quantity of water dispensed by the holding tank or supply vehicle;

(I) The rates of recycling additive, engineered emulsion, and mixing water shall be calculated based on field measurements in items f, g, and h, and compared to the rates determined by the computerized metering and proportioning system;

(J) Any stoppage, interruption, malfunction, or apparent deficiency shall be investigated;

(K) Application of fog/tack coat shall be complete, uniform, cured, and at an appropriate rate as verified by the amount of emulsion applied and area covered;

(L) Traffic behavior shall be monitored to ensure no stopping/starting movements occur on newly placed cold recycled material; and

(M) All printouts for quantities used in the daily measurements shall be submitted.

408-10 Acceptance:

Compacted cold recycled material that has been constructed in accordance with the requirements herein and has maintained both stability and surface integrity to the satisfaction of the Engineer, for which test results indicate conformance to the requirements herein, will

be accepted at the time of placement of the required surface treatment or overlay.

Acceptance will be on a lot basis; a lot being one day's production. Acceptance will be on the basis of the following:

(A) Emulsion content;
(B) Compaction;
(C) Moisture content; and
(D) Surface requirements and tolerances

408-10.01 Emulsion Content:

Acceptance for emulsion content will be determined by measured quantities of materials included in each of, at minimum, four equal sub-lots in each lot's production. Additional sub-lots will be required to accurately account for adjustments to the emulsion rate during production. The Engineer will verify the total amount of emulsion reported for each sub-lot based on the Daily Production Reports generated from the computer monitoring and metering system on the cold in-place recycling train or in the cold central plant recycling plant and the target rate used during production.

The Engineer will compare the required quantity of emulsion to the actual quantity of emulsion used. The lot will be considered to be acceptable if the actual quantity of emulsion used in each sub-lot constitutes an emulsion rate within ± 0.3 percent of the target rate(s) designated by the contractor during production.

For deficiencies in emulsion content, the contractor may either re-recycle the cold recycled material or completely remove the unacceptable cold recycled material. Removed cold recycled material shall be replaced with material meeting the requirements of Section 409, 416, or 417 of the specifications, as determined by the Engineer.

408-10.02 Compaction and Moisture Content:

Acceptance for compaction and moisture content will be determined from four cores for each lot taken by the contractor at random locations determined by the Engineer prior to any placement of surface treatment or overlay. No core will be taken from within 1 foot of a longitudinal joint or 100 feet from a transverse joint. Cores shall be taken in the presence of the Engineer by the contractor utilizing base mounted mechanical coring equipment in accordance with the requirements of AASHTO R 97 except that compressed air shall be used in place of water. The bulk density and moisture content of each core will be determined by the Engineer in accordance with AASHTO T 166, Vacuum Method.

The contractor's QC shall determine the in-place density of the designated core locations with a thin lift nuclear density gauge in the

presence of the Engineer prior to coring. If undisturbed, intact cores cannot be obtained, the density used for acceptance will be that of the nuclear density gauge and moisture content will be determined by the Engineer in accordance with AASHTO T 255 from the recovered cold recycled material.

Cold recycled material meeting the requirements herein and compacted to not less than 98 percent of the associated field compacted specimens will be accepted at the bid item price. The core density will be compared to the nearest adjacent field compacted specimen representative of the production from where the core was obtained.

Cold recycled material not meeting this requirement for compaction will be rejected and shall be corrected by means of additional compaction or re-recycling and re-compacting. If additional effort does not result in acceptable cold recycled material, the material shall be removed and replaced with material meeting the requirements of Section 409, 416, or 417 of the specifications, as determined by the Engineer.

The moisture content of the material obtained from coring shall be 2.0 percent or less, or if 10 consecutive days without precipitation have occurred, no more than 0.5 percent greater than the moisture content of the existing pavement prior to cold recycling operations.

408-10.03 Surface Requirements and Tolerances:

The recycled asphaltic concrete shall be compacted smooth and reasonably true to the required lanes, grades, and dimensions.

The finished surface shall not vary more than 3/8 inch from the lower edge of a 10-foot straightedge, when the straightedge is placed both parallel and perpendicular to the centerline of the roadway.

Humps or otherwise elevated areas shall be corrected by reworking, additional rolling, trimming, milling, or abrasive grinding. Depressions shall be corrected by milling to sufficient depth and applying a tack coat of emulsified asphalt to accommodate a patch consisting of cold recycled material, or warm or hot mix asphalt, meeting the requirements of Section 409, 416, or 417 of the specifications, as determined by the Engineer.

408-11 Method of Measurement:

The cold recycled material will be measured by the square yard, completed in place, and accepted by the Engineer.

The engineered emulsion and mineral admixture(s) will be measured by the ton.

408-12 Basis of Payment:

The accepted quantities of cold recycled material, measured as provided above, will be paid for at the contract unit price per square yard for the material complete in-place. Material meeting the requirements of Sections 409, 416, and/or 417 of the specifications, and placed in locations where cold recycled material was removed, will be paid for at the bid item price for Cold Recycling.

The engineered emulsion measured as provided above will be paid for by the ton. The contract unit price for engineered emulsion will be adjusted for quantities of material represented by corresponding test results. Adjustments will be made in accordance with the requirements of Subsection 1005-3.03 of the specifications.

Mineral admixture will be paid for at the predetermined price established in the Bidding Schedule.

SECTION 409 ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL):

409-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete (Miscellaneous Structural), hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, reclaimed asphalt pavement (RAP) if used, mineral admixture, and bituminous material (asphalt cement) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications, and as directed by the Engineer.

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

409-2 Materials:

409-2.01 Mineral Aggregate:

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity	Arizona Test Method 251	2.350 - 2.850
Combined Water Absorption	Arizona Test Method 251	0 – 3.0%

Mineral Aggregate Characteristics	Test Method	Requirement
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Sand Equivalent	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 4 material is required.)	Minimum 55
Fractured Coarse Aggregate Particles	AASHTO T 335	Minimum 70% (plus No. 4 material)
Carbonates (1)	Arizona Test Method 238	Maximum 20%

Notes:

(1) Testing for carbonates only applies if either of the following conditions exist:

(a) The asphaltic concrete is the designed final pavement surface normally used by traffic; or

(b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.

The gradation will be determined in accordance with AASHTO T 11 and AASHTO 27, and shall conform to the requirements given below.

Mix Design Grading Limits						
Sieve Size	Percent Passing					
	Lift Thickness Less Than 1½ Inches		Lift Thickness 1½ to 2 Inches		Lift Thickness Greater Than 2 Inches	
	Without Admixture	With Admixture	Without Admixture	With Admixture	Without Admixture	With Admixture
1 Inch					100	100
3/4 Inch			100	100	90-100	90-100
1/2 Inch	100	100	90-100	90-100	---	---
3/8 Inch	90-100	90-100	70-85	70-85	70-85	70-85
No. 8	41-55	42-56	41-51	42-52	41-51	42-52
No. 40	9-19	10-20	---	---	---	---
No. 200	2.0-5.0	3.0-6.5	2.0-5.0	3.0-6.5	2.0-5.0	3.0-6.5

409-2.02 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder, conforming to the requirements of Section 1005 of the specifications. The type of asphalt binder shall be as shown in the Special Provisions.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity of 0.17 ± 0.02 Pascal·seconds, measured in accordance with AASHTO T 316. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity of 0.28 ± 0.03 Pascal·seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 degrees F and 350 degrees F, and a viscosity-temperature curve developed in accordance with ASTM D2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 degrees F or a maximum laboratory compaction temperature exceeding 300 degrees F, the laboratory mixing and compaction temperature ranges shall be specified in writing by the asphalt binder supplier. The laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used, shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report. The laboratory mixing and compaction temperatures are for mix design purposes only. Field mixing and compaction temperatures are specified in Subsection 409-3 of the specifications.

409-2.03 Mineral Admixture:

Mineral admixture shall be either Portland cement, blended hydraulic cement, or hydrated lime conforming to the following requirements:

Material	Requirement
Portland Cement, Type I or II	ASTM C150
Blended Hydraulic Cement, Type IP or 1L	ASTM C595
Hydrated Lime	ASTM C1097

The mineral admixture content shall be 2.0 percent, by weight, of the mineral aggregate. However, a minimum of 1.0 percent mineral admixture may be used if the contractor submits test information showing a lowered percentage of mineral admixture produces mix design results for Index of Retained Strength of at least 60 percent and a Minimum Wet Strength of 150 pounds per square inch when tested in accordance with Arizona Test Method 802.

The certification and acceptance of Portland cement, blended hydraulic cement, and hydrated lime shall be in accordance with ADOT Materials Practice and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

409-2.04 Mix Design:

Utilizing mineral aggregate which has been crushed, processed, separated, and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate samples used for mix design purposes shall be representative of aggregate materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements specified herein, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

Mix designs shall be developed utilizing a minimum ratio of three (3) for the lift thickness to nominal maximum aggregate size. The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. Reclaimed asphalt pavement (RAP) may be used in the mixture if properly designed per Arizona Test Method 833. Limits for the usage of RAP shall be per ADOT Materials Practice and Procedure Directive No. 20, “Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete”. The mix design engineer shall meet the requirements given in ADOT Materials Practice and Procedure Directive No. 4, “Asphaltic Concrete Mix Design Proposals and Submittals”. The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Practice and Procedure Directive No. 19, “ADOT System for the Evaluation of Testing Laboratories”.

If approved by the Engineer, as an alternative to meeting the mix design requirements specified herein, a mix design meeting the requirements of either Section 416 or Section 417 of the specifications may be substituted for use. The type of asphalt binder used in the alternative mix design shall be the same as that specified in Subsection 409-2.02 of the specifications. The alternative mix design may include reclaimed asphalt pavement (RAP) if properly designed per Arizona Test Method 833. If a mix design meeting the requirements of Section 417 is used, the number of gyrations for N design used in the alternative mix design must be at least that which would be specified at the location where the Asphaltic Concrete (Miscellaneous Structural Special Mix) is to be placed. The lift thickness for the alternative mix design shall conform to the following table.

Alternative Mix Design	Minimum Lift Thickness
Section 416 (1/2 inch Special Mix)	1-1/2 inches
Section 416 (3/4 inch Special Mix)	2 inches
Section 417 (1/2 inch Mix)	2 inches
Section 417 (3/4 inch Mix)	2-1/2 inches

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing mineral aggregate, and RAP material if applicable, have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate, and RAP material if applicable, proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a previously used mix design may be used for the duration of that project.

Test results used in the formulation of the mix design must be from testing performed no earlier than 45 days prior to the date the mix design is signed by the mix design engineer. Historical abrasion values may be supplied on sources provided the testing was conducted within the past two years.

The mix design shall be submitted to the Engineer under a cover letter signed by an authorized representative of the contractor.

The mix design shall be submitted to the Engineer for review a minimum of five working days prior to the start of production.

The mix design shall meet the following criteria when tested in accordance with the requirements of the following test methods:

Criteria	Requirement	Arizona Test Method
1.Voids in Mineral Aggregate: %, Range	14.5 - 18.5	(See Note 1)
2.Effective Voids: %, Range	3.8 - 4.2	(See Note 1)
3. Absorbed Asphalt: %, Range	0 - 1.0	(See Note 1)

Note:

(1) For mixes without RAP, Arizona Test Method 815. For mixes with RAP, Arizona Test Method 833.

The Engineer reserves the right to adjust the asphalt content during production from the mix design value without additional compensation to the contractor in order to obtain desirable effective voids.

409-2.05 Sampling and Testing:

Sampling and testing the materials and mixture for quality control purposes shall be the contractor's responsibility. The contractor shall perform sufficient testing to assure that mineral aggregate and asphaltic concrete are produced which meet all specified requirements. The Engineer reserves the right to sample and test the materials and mixture when necessary to determine that they reasonably conform to the requirements specified herein.

409-3 Construction Requirements:

409-3.01 General:

All courses of asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The following requirements shall be met:

(A) The surface of the final lift of asphaltic concrete placed under this section of the specifications shall be tested and shall not vary by more than 1/8 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints;

(B) The surface of any lift of asphaltic concrete placed under this section of the specifications, other than the final lift, shall be tested and shall not vary by more than 1/4 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints; and

(C) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the specifications.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless the collected fines are accurately and uniformly metered into the mixture.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 degrees F, unless a higher temperature is recommended in writing by the asphalt binder supplier and approved by the Engineer.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with the requirements of AASHTO T 329.

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors shall be wetted with water, or if necessary soapy water, or a release agent in order to prevent the sticking of asphaltic concrete. All other equipment surfaces shall be treated when necessary with a release agent. Only release agents evaluated through AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) are acceptable for use. The results from AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) testing, when tested in accordance with AASHTO T 383, shall conform to the requirements shown in the table below:

RELEASE AGENT TEST	REQUIREMENT
Asphalt Stripping Test Diluted Non-Diluted (Full Strength)	 No Stripping No Stripping
Asphalt Performance Test	Less than or equal to 10.0% after the third cycle

Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Asphaltic concrete immediately behind the laydown machine shall be in a thoroughly mixed, free-flowing, and workable condition, be free of lumps and crusts, and have a minimum temperature of 275 degrees F.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at

certain locations where the Engineer deems the use of self-propelled paving machines impractical.

The speed of the paving machine shall be coordinated with the production of the plant and an adequate number of trucks for hauling asphaltic concrete shall be available in order to achieve, as far as practical, a continuous operation.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Pavers shall be equipped with a screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with bituminous material in accordance with the requirements of Section 404 of the specifications.

Longitudinal joints of each course shall be staggered a minimum of 1 foot with relation to the longitudinal joint of any immediate underlying course. Longitudinal joints shall be located within 1 foot of the center of a lane or within 1 foot of the centerline between two adjacent lanes.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

409-3.02 Compaction:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	2 - 6*	2 - 4*
Finish	Static Steel	Static Steel	1 - 3	1 - 3
Note: * Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure.

Steel wheel compactors shall not be used in the vibratory mode for courses of 1 inch or less in nominal thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F. Steel wheel compactors shall weigh not less than 8 tons.

Initial and intermediate compaction shall be completed before the temperature of the asphaltic concrete falls below 200 degrees F. All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified and with the number of coverages of the compactors as specified.

409-3.03 Acceptance:

Asphaltic concrete will be accepted complete in place, if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

409-4 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, bituminous material, and mineral admixture. Measurement will include any weight used in construction of intersections, turnouts, curbs, spillways and

spillway inlets, ditches, catch basin entrances, median strips, sidewalks, or other miscellaneous items or surfaces.

409-5 Basis of Payment:

409-5.01 General:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton for the bituminous mixture complete in place.

No direct payment will be made for the bituminous material and mineral admixture in the asphaltic concrete, or the bituminous material for tack coat and application of tack coat, the price being considered as included in the price paid for asphaltic concrete.

Asphaltic concrete may be measured, by volume, upon the execution of a supplemental agreement which will specify the manner in which the volume is determined. The volume will include the volume of mineral aggregate, bituminous material, mineral admixture, and any necessary blending material.

409-5.02 Reduction for Noncompliance:

A reduction in payment to the contractor for asphaltic concrete will be made for quantities of asphalt cement (bituminous material) that do not meet the requirements of Section 1005 as determined by corresponding test results. Adjustments in payment will be made in accordance with the requirements of Table 1005-1.

SECTION 410 ASPHALT-RUBBER STRESS-ABSORBING MEMBRANE:

410-1 Description:

The work under this section shall consist of furnishing all materials including asphalt-rubber, tack coat, and cover material, and applying the materials in accordance with the details shown on the project plans and the requirements of the specifications.

410-2 Materials:

410-2.01 Tack Coat:

Prior to the application of the asphalt rubber stress-absorbing membrane, the existing pavement surface shall be cleaned of all objectionable material and tacked with a light coat of bituminous material in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface,

and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by the Engineer; however, the application rate shall not exceed 0.06 gallons per square yard.

410-2.02 Asphalt-Rubber:

Asphalt-Rubber shall conform to the requirements of Section 1009 of the specifications. The type of asphalt-rubber shall be as shown in the Special Provisions. The crumb rubber gradation shall be Type A conforming to the requirements of Section 1009 of the specifications.

410-2.03 Cover Material:

Cover material shall conform to the requirements of Subsection 404-2.02(C) of the specifications. The class of cover material shall be as shown in the Special Provisions.

Prior to placing, the cover material shall be precoated with any grade of PG asphalt cement which meets the requirements of Section 1005 of the specifications. The precoating shall be accomplished by mixing at a central plant until the aggregate is thoroughly coated. The cover material shall have a minimum temperature of 250 degrees F at the time of precoating with asphalt cement. The cover material shall be precoated with approximately 0.40 percent to 0.60 percent asphalt cement, by weight of the aggregate. The final percentage of asphalt cement used for precoating will be as directed by the Engineer. The end result shall be a dust free material.

410-3 Construction Requirements:

410-3.01 General:

All equipment used to mix and apply asphalt-rubber material shall meet the requirements specified under Subsection 404-3.02(A) of the specifications. The equipment shall also be capable of maintaining a uniform, homogeneous mixture throughout the operation.

410-3.02 Application of the Asphalt-Rubber Stress-Absorbing Membrane:

Asphalt-rubber stress-absorbing membranes shall be placed between the dates below for the average elevation of the project.

Average Elevation of Project, Feet	Beginning and Ending Dates
0 – 3499	March 15 – May 31
0 – 3499	September 1 – October 31
3500 – 4999	April 15 – October 15
5000 and over	June 1 – September 15

The existing pavement shall be cleaned in accordance with the requirements of Subsection 404-3.04 of the specifications.

After cleaning and prior to the application of the membrane, the existing pavement surface shall be treated with a tack coat as hereinbefore specified.

Placement of the asphalt-rubber membrane shall be made only when all of the following conditions are met:

(A) The pavement surface temperature is above 75 degrees F;

(B) The pavement is dry;

(C) The wind conditions are such that a satisfactory membrane can be achieved; and

(D) All construction equipment such as asphalt-rubber distributor, aggregate spreader, haul trucks with cover material, and rollers are in position and ready to commence placement operations.

The distributor shall be capable of spreading the asphalt-rubber mixture in accordance with the tolerances specified in Subsection 404-3.02(A) of the specifications except that the maximum deviation from the specified rate shall not exceed 0.05 gallons per square yard.

The hot asphalt-rubber mixture shall be applied at the rate of approximately 0.55 ± 0.05 gallons per square yard (based on a unit weight of 7.75 pounds per gallon of hot asphalt-rubber); however, the Engineer will specify the exact rate based on existing surface conditions.

All transverse joints shall be made by placing building paper over the end of the previous application, and the joining application shall start on the building paper. Once the application process has progressed beyond the paper, the paper shall be disposed of as directed by the Engineer.

All longitudinal joints shall be lapped approximately 4 inches.

Traffic shall not be permitted on the asphalt-rubber membrane prior to the application of cover material.

410-3.03 Application of Cover Material:

Cover material shall be applied in accordance with the requirements of Subsection 404-4.04(E) of the specifications.

Cover material shall be immediately and uniformly spread over the freshly applied asphalt-rubber at the rate of approximately 0.014 cubic

yards per square yard; however, the actual rate of application will be determined by the Engineer.

410-3.04 Rolling:

At least three pneumatic-tired rollers shall be provided to accomplish the required rolling. The rollers shall conform to the requirements of Subsection 416-7.05(A)(2) of the specifications, except that the minimum air pressure in each tire shall be 100 pounds per square inch, and steel wheel rollers shall not be used.

A sufficient number of rollers shall be furnished to cover the width of the spread on the first pass and complete the required number of passes within the time specified hereinafter. The first pass shall be made immediately behind the spreader and if the spreading is stopped for any reason, the spreader shall be moved ahead so that all cover material may be immediately rolled. The rolling shall continue until a minimum of four complete coverages have been made. Final rolling shall be completed in accordance with the following:

Existing Pavement Temperature	Complete Rolling Within
100° F and above	20 Minutes
Below 100° F	10 Minutes

410-3.05 Traffic:

Traffic of all types shall be kept off the stress-absorbing membrane until it has had time to set properly. The minimum traffic free period shall be three hours. However, when it is absolutely necessary that hauling equipment or piloted traffic travel on the newly applied membrane and the use is approved in advance by the Engineer, the speed shall not exceed 15 miles per hour. Stress-absorbing membrane operations shall be scheduled so that the normal flow of traffic will be resumed before sunset.

410-3.06 Removing Loose Cover Material:

Loose cover material shall be removed in accordance with the requirements of Subsection 404-4.04(G) of the specifications. Sweeping shall be completed and all excess cover material removed prior to the placement of any subsequent layers of asphaltic concrete.

410-3.07 Placement of Asphaltic Concrete:

If the asphalt-rubber membrane has been subjected to traffic, a tack coat, as hereinbefore specified, shall be applied at the rate of approximately 0.06 gallons per square yard prior to placement of the asphaltic concrete.

When asphaltic concrete is to be placed over the asphalt-rubber membrane, it shall be placed as soon as practicable; however, in no

instance shall it be placed later than seven days after membrane placement.

410-4 Method of Measurement:

Asphalt-rubber material will be measured by the ton. Conversion from volume to weight will be calculated on the basis of 7.75 pounds per gallon of hot asphalt-rubber material.

Cover material will be measured by the cubic yard. Cover material will be weighed before precoating, and the amount in tons of dry material will be converted to cubic yards. The weight of all moisture contained in the cover material will be deducted prior to the conversion of the weight in tons to the volume in cubic yards. The dry weight per cubic foot will be determined in accordance with the requirements of AASHTO T 19 (Shoveling Procedure).

The quantities of bituminous tack coat and time to apply tack coat will be measured in accordance with the requirements of Section 404 of the specifications.

410-5 Basis of Payment:

The accepted quantity of asphalt-rubber, measured as provided above, will be paid for at the contract unit price for the asphalt-rubber mixture complete in place, including asphalt cement and crumb rubber.

The accepted quantity of cover material, measured as provided above, will be paid for at the contract unit price, complete in place, including precoating material, and rolling and removal of loose cover material.

The accepted quantities of bituminous tack coat and time to apply tack coat will be paid for in accordance with the requirements of Section 404 of the specifications.

The bidding schedule reflects a quantity of bituminous tack coat based on two applications of emulsified asphalt at the specified rate. No adjustment in the contract unit prices will be made because of a variation in the quantities actually required to complete the work.

SECTION 411 ASPHALTIC CONCRETE FRICTION COURSE (MISCELLANEOUS):

411-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete Friction Course (Miscellaneous), hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and

bituminous material (asphalt cement) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications, and as directed by the Engineer.

411-2 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated as shown in the Special Provisions.

411-2.01 Mineral Aggregate:

Mineral aggregate shall be separated into at least two stockpiles. No individual stockpile or hot bin usage shall be less than 3 percent of the total mineral aggregate.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate or blend material shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Sand Equivalent	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 8 material is required.)	Minimum 55
Fractured Coarse Aggregate Particles	AASHTO T 335	Minimum 85% (at least two fractured faces) and minimum 92% (at least one fractured face)
Flakiness Index	Arizona Test Method 233	Maximum 25%
Carbonates	Arizona Test Method 238	Maximum 20%

The gradation will be determined in accordance with AASHTO T 11 and AASHTO T 27, and shall conform to the requirements given below.

Sieve Size	Percent Passing	
	Without Mineral Admixture	With Mineral Admixture
3/8 Inch	100	100
No. 4	35 - 60	36 - 60
No. 8	10 - 18	11 - 19
No. 200	0 - 2.5	0 - 3.5

411-2.02 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate. Mineral admixture shall be either Portland cement, blended hydraulic cement, or hydrated lime conforming to the following requirements:

MINERAL ADMIXTURE	
Material	Requirement
Portland Cement, Type I, or Type II	ASTM C150
Blended Hydraulic Cement, Type IP	ASTM C595
Hydrated Lime	ASTM C1097

The certification and acceptance of Portland cement, blended hydraulic cement, and hydrated lime shall be in accordance with ADOT Materials Policy and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

411-2.03 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005 of the specifications. The type of asphalt binder shall be as shown in the Special Provisions.

The exact percent of asphalt cement to be used will be specified by the Engineer.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

411-2.04 Proportions:

The asphalt cement content will be specified by the Engineer and will be appropriate with the characteristics of the mineral aggregate furnished from which the asphaltic concrete is to be produced.

411-2.05 Sampling and Testing:

Sampling and testing the materials and mixture for quality control purposes shall be the contractor's responsibility. The contractor shall perform sufficient testing to assure that mineral aggregate and asphaltic concrete are produced which meet all specified requirements. The Engineer reserves the right to sample and test the materials and mixture when necessary to determine that the materials and mixture reasonably conform to the requirements specified herein.

411-3 Construction Requirements:

411-3.01 General:

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the specifications.

Just prior to being placed, the asphaltic concrete shall be in a thoroughly mixed condition, free of lumps and crusts and at such a temperature as to be in a free flowing, workable condition.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with bituminous material in accordance with the requirements of Section 404 of the specifications.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the dryer shall not exceed 275 degrees F, unless otherwise approved by the Engineer.

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 75 degrees F.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

The asphaltic concrete shall be placed, using approved equipment and methods, to the lines and grades shown on the project plans and as directed by the Engineer.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

411-3.02 Compaction:

(A) General Requirements:

The temperature of the asphaltic concrete just prior to compaction shall be at least 200 degrees F.

(B) Equipment:

Compacting and smoothing shall be accomplished by the use of static steel wheel compactors. Vibrator compactors may be used in the static mode only. The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. A minimum of three compactors shall be provided; however, sufficient compactors shall be provided so that the drums of the compactors when staggered will cover the entire width of the paving machine during initial breakdown.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Compactors shall weigh not less than 8 tons.

(C) Rolling Procedure:

A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

Compaction shall consist of the following rolling sequence:

Rolling Sequence	Number of Coverages
Initial	1
Finish	1 - 2

A sufficient number of compactors shall be used for initial breakdown so that when the compactors are staggered the entire width of the mat being laid is compacted with one forward pass of the compactors. The distance between the paving machine and the initial rolling shall not exceed 200 feet.

A separate roller(s) shall be used for final compaction. The roller(s) used for final compaction shall follow as closely behind the initial breakdown rollers as possible.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated in accordance with the manufacturer's recommendations and with the number of coverages of the compactors as specified.

411-3.03 Acceptance:

Asphaltic concrete will be accepted complete in place, if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

411-4 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, mineral admixture, and bituminous material. Measurement will include any quantity used in construction of intersections, turnouts, curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks, or other miscellaneous items or surfaces.

411-5 Basis of Payment:

411-5.01 General:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton for the bituminous mixture complete in place.

No direct payment will be made for the bituminous material and mineral admixture in the asphaltic concrete, or the bituminous material for tack coat and application of tack coat, the price being considered as included in the price paid for asphaltic concrete.

Asphaltic concrete may be measured, by volume, upon the execution of a supplemental agreement which will specify the manner in which the volume is determined. The volume will include the volume of mineral aggregate, mineral admixture, and bituminous material.

411-5.02 Reduction for Noncompliance:

A reduction in payment to the contractor for asphaltic concrete will be made for quantities of asphalt cement (bituminous material) that do not meet the requirements of Section 1005 of the specifications as determined by corresponding test results. Adjustments in payment will be made in accordance with the requirements of Table 1005-1 and the following formula:

$$R=(100-P) \times \left[\frac{(CP) \times T}{100}\right]$$

Where: R= Amount of reduction in payment (dollars)

T= Quantity of asphalt cement in failure (tons, rounded to nearest 0.1)

P= Percent of contract unit price allowed (Table 1005-1)

CP= Current Price for asphalt cement (bituminous material), as determined by the Department, for the month in which a deficiency was noted. This value will be posted on the ADOT Contracts and Specifications Group website, on or shortly after the last Wednesday of each month.

SECTION 412 PAVEMENT FABRIC INTERLAYER:

412-1 Description:

The work under this section shall consist of furnishing and placing a pavement fabric and applying an asphalt binder coat between pavement layers or beneath a pavement overlay to provide a waterproofing and stress relieving membrane within the pavement structure, in accordance with the details shown on the project plans and the requirements of the specifications.

412-2 Materials:

412-2.01 Pavement Fabric:

The pavement fabric shall be supplied in accordance with and conform to the material requirements of Subsections 1014-1 and 1014-2 of the specifications.

412-2.02 Asphalt Binder Coat:

The asphalt binder coat is used to bond or tack the fabric to the pavement and perform a sealant function, providing a barrier to moisture infiltration. The bituminous material for the binder coat shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005 of the specifications, as approved by the Engineer. The use of cutback or emulsified asphalts will not be allowed.

412-2.03 Blotter Material:

Blotter material shall meet the requirements of Subsection 404-2.02(B) of the specifications.

412-2.04 Fabric Packaging, Handling, and Storing:

The identification, packaging, handling, and storing of the geotextile fabric shall be in accordance with ASTM D4873. Fabric rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Rolls will be stored on the site or at another identified storage location in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover. At no time, shall the fabric be exposed to ultraviolet light for a period exceeding seven days.

412-3 Construction Requirements:

412-3.01 Weather Limitations:

Neither the asphalt binder coat nor fabric shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. For placement of the asphalt binder coat, the minimum air and pavement temperature shall be 50 degrees F and rising. Air and pavement temperature shall also be sufficient to allow the asphalt binder coat to hold the fabric in place.

412-3.02 Equipment:

(A) Asphalt Distributor Truck:

The asphalt distributor truck shall meet the minimum requirements of Subsection 404-3.02(A) of the specifications. The asphalt distributor truck shall be capable of spraying the asphalt binder coat at the application rate as approved by the Engineer. No streaking, skipping, or dripping will be permitted. The distributor truck shall also be equipped with a hand spray attachment having a single nozzle and positive shut-off valve.

(B) Fabric Handling Equipment:

Mechanical or manual laydown equipment shall be capable of laying the fabric smoothly.

(C) Miscellaneous Equipment:

Stiff bristle brooms or squeegees to smooth the fabric, scissors or blades to cut the fabric, and brushes for applying asphalt at fabric overlaps shall be provided. Pneumatic rolling equipment to smooth the fabric into the asphalt binder, sanding equipment to apply a blotter sand, and brooming equipment may be required by the Engineer to improve the installation procedure. Refer to Subsections 404-3.02(B), (C), and (D) of the specifications for equipment requirements.

412-3.03 Surface Preparation:

The pavement surface on which the fabric is to be placed shall be cleaned to remove all dirt, water, oil and any vegetation or debris.

412-3.04 Application of the Asphalt Binder Coat:

The asphalt binder coat shall be uniformly spray applied to the prepared dry pavement surface by means of the asphalt distributor truck at the rate of 0.25 gallons per square yard or as recommended by the fabric manufacturer and as approved by the Engineer. Some underlying surfaces may require a higher or lower application rate. A test strip may be necessary to determine the proper application rate.

Application of the asphalt binder coat shall be primarily by the distributor truck spray bar with hand spraying kept to a minimum. Temperature of the asphalt binder coat shall be sufficiently high to permit a uniform spray pattern. The minimum temperature of asphalt in the distributor tank shall be 290 degrees F. However, to avoid damage to the fabric, the asphalt temperature in the tank shall not exceed 325 degrees F.

The target width of the asphalt binder application shall be the width of the pavement fabric plus 6 inches. The asphalt binder shall be applied only as far in advance of the fabric installation as is appropriate to ensure a tacky binder surface at the time of the fabric placement. Fabric shall be placed the same workshift as the asphalt binder coat is applied. Traffic shall not be allowed on the asphalt binder coat. Excess asphalt or spills shall be cleaned from the road surface to avoid flushing and fabric movement.

412-3.05 Fabric Placement:

The fabric shall be placed, with the heat bonded side up, on the asphalt binder coat using mechanical or manual laydown equipment capable of providing a smooth installation of the fabric with a minimum amount of wrinkling or folding. Placement of the fabric will take place prior to the time when the asphalt binder coat has cooled enough to start losing its tackiness. Wrinkles or folds which remain in the fabric and are large enough to be folded over 1/2 inch or more shall be slit and laid flat into the binder coat. Slit folds or wrinkles shall be shingle-lapped in the direction of the paving operation. Brooming and/or pneumatic rolling will be required to maximize fabric contact with underlying pavement surface.

Overlap of fabric joints shall be a minimum of 3 inches to ensure full closure of the joint, but shall not exceed 6 inches. Transverse joints shall be lapped in the direction of paving to prevent edge pickup by the paver. The center of a longitudinal overlapped joint shall be located within 1 foot of the center of a lane or within 1 foot of the centerline between two adjacent lanes. A second application of hand-placed

asphalt binder may be required at laps and repairs as determined by the Engineer to ensure proper binding of the narrow double fabric layer.

All areas with fabric placed shall be paved the same workshift. No vehicles or equipment except necessary construction equipment as approved by the Engineer and emergency vehicles will be allowed to drive on the fabric.

Removal and replacement of any fabric that is damaged will be the responsibility of the contractor.

412-3.06 Application of Blotter Materials:

Blotter material may be spread over asphalt-saturated fabric, if approved by the Engineer, to facilitate movement of equipment during construction or to prevent tearing or delamination of the fabric. If blotter sand is applied, excess quantities shall be removed from the fabric prior to placing the asphaltic concrete.

412-3.07 Placement of the Asphaltic Concrete:

All areas where fabric has been placed shall be paved with asphaltic concrete during the same work shift. Placement of the asphaltic concrete shall closely follow fabric lay down. The temperature of the asphaltic concrete when delivered shall not exceed 325 degrees F. In the event that asphalt binder coat bleeds through the fabric causing construction problems before the overlay is placed, the affected areas shall be blotted by spreading blotter sand. Excess sand shall be removed before beginning the paving operation. In the event of a rainfall on the fabric prior to the placement of the asphaltic concrete, the fabric must be allowed to dry completely before the asphaltic concrete is placed. To avoid movement or damage to the fabric during the paving operation, the turning of the paver and other vehicles shall be gradual and kept to a minimum.

412-4 Method of Measurement:

The pavement fabric interlayer will be measured by the square yard, in-place.

Bituminous material that is required for the asphalt binder coat will be measured by the ton.

Time to apply the asphalt binder coat is defined as the hours within a work shift that an approved distributor truck containing the specified bituminous material is required by the Engineer to be at the work site.

The time which is required to apply the asphalt binder coat will be measured to the nearest hour for the actual number of hours required in any one work shift; however, when the time required is less than four hours in any work day, the time will be measured as four hours.

412-5 Basis of Payment:

The accepted quantities of pavement fabric, measured as provided above, will be paid for at the contract unit price per square yard which price shall be full compensation for furnishing all labor, materials, and equipment, and performing all operations in connection with placing the pavement fabric interlayer as shown on the project plans and as specified and described herein.

The accepted quantities of bituminous material for the asphalt binder coat complete in place, measured as provided above, will be paid for at the contract unit price per ton, except that adjustments in the contract unit price, in accordance with the requirements of Table 1005-1, will be made for the quantities of material represented by the corresponding test results.

Payment for all measures necessary to direct and escort traffic through the area where the pavement fabric is being placed will be made as specified under Section 701 of the specifications.

No measurement or direct payment will be made for pneumatic rolling or brooming which is required or at the direction of the Engineer.

No measurement or direct payment will be made for furnishing, applying, and removing sand blotter material which may be required by the Engineer.

The accepted quantity of time to apply the asphalt binder coat, measured as provided above, will be paid for at the contract unit price per hour, which payment shall be full compensation for applying the asphalt binder coat.

SECTION 413 BLANK:

SECTION 414 ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT-RUBBER):

414-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete Friction Course (Asphalt-Rubber), hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt-rubber) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications, and as directed by the Engineer.

414-2 Asphaltic Concrete Mix Design Criteria:

Mix designs will be performed in accordance with Arizona Test Method 814, modified as necessary for Asphaltic Concrete Friction Course (Asphalt-Rubber). The allowable range of percent absorbed asphalt-rubber shall be 0-1.0, when tested in accordance with Arizona Test Method 806.

414-3 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated as shown in the Special Provisions.

414-3.01 Mineral Aggregate:

The contractor shall provide a source of mineral aggregate in accordance with the requirements of Section 1001 of the specifications.

When the contractor selects a source or sources, it shall notify the Engineer. The contractor shall be solely responsible for assuring that the mineral aggregate meets all requirements and, when processed, is fully capable of providing asphaltic concrete which meets all the requirements of these specifications.

Mineral aggregate shall be separated into at least two stockpiles. No individual stockpile or hot bin usage shall be less than 3 percent of the total mineral aggregate.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate or blend material shall consist of natural sand, sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

Mineral aggregate furnished for mix designs shall be representative of the source(s) and sampled from the material stockpiles to be utilized in asphaltic concrete production. Mix designs shall conform to the grading limits in Table 414-1, when tested in accordance with AASHTO T 11 and AASHTO T 27.

TABLE 414-1
MIX DESIGN GRADING LIMITS

Sieve Size	Percent Passing	
	Without Admixture	With Admixture
3/8 Inch	100	100
No. 4	30 - 45	31 - 46

No. 8	4 - 8	5 - 9
No. 200	0 - 2.0	0 - 3.0

Mineral aggregate shall conform to the requirements in Table 414-2 when tested in accordance with the applicable test methods.

Tests on aggregates outlined in Table 414-2, other than abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on samples from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

TABLE 414-2
MINERAL AGGREGATE CHARACTERISTICS

Characteristic	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity	Arizona Test Method 251	2.350 - 2.850
Combined Water Absorption	Arizona Test Method 251	0 – 2.5%
Sand Equivalent	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 8 material is required.)	Minimum 55
Fractured Coarse Aggregate Particles	AASHTO T 335	Minimum 85% (at least two fractured faces) and minimum 92% (at least one fractured face)
Flakiness Index	Arizona Test Method 233	Maximum 25%
Carbonates	Arizona Test Method 238	Maximum 20%
Abrasion	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%

414-3.02 Mineral Admixture:

Mineral admixture will be required. The amount shall be 1.0 percent, by weight of the mineral aggregate. Mineral admixture shall be either Portland cement, blended hydraulic cement, or hydrated lime conforming to the requirements of Table 414-3.

TABLE 414-3
MINERAL ADMIXTURE

Material	Requirement
Portland Cement, Type I or, Type II	ASTM C150
Blended Hydraulic Cement, Type IP	ASTM C595
Hydrated Lime	ASTM C1097

The certification and acceptance of Portland cement, blended hydraulic cement (Type IP), and hydrated lime shall be in accordance with

Materials Practice and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

414-3.03 Bituminous Material:

Bituminous material shall be asphalt-rubber conforming to the requirements of Section 1009 of the specifications. The type of asphalt-rubber shall be as shown in the Special Provisions. The crumb rubber gradation shall be Type B conforming to the requirements of Section 1009 of the specifications.

The percent of asphalt-rubber used shall be based on the weight of total mix (asphalt-rubber, mineral aggregate, and mineral admixture).

The percent of asphalt-rubber to be used will be specified by the Engineer.

In no case shall the asphalt-rubber be diluted with extender oil, kerosene, or other solvents. Any asphalt-rubber so contaminated will be rejected.

Any kerosene or other solvents used in the cleaning of equipment shall be purged from the system prior to any subsequent use of that equipment.

414-4 Mix Design:

Approximately 300 pounds of produced mineral aggregate, in proportion to the anticipated percent usage, shall be obtained by the contractor and witnessed by the Engineer so that both parties are satisfied that samples are representative of the mineral aggregate to be utilized in the asphaltic concrete production.

In addition to the mineral aggregate samples, the contractor shall also furnish the Engineer with representative samples of the following materials: a 5-pound sample of the crumb rubber proposed for use, 1 gallon of asphalt cement from the intended supplier, 3 gallons of the proposed mixture of asphalt and rubber, and a 1-gallon can of the proposed mineral admixture. These materials must be representative of the material which will subsequently be used in the production of asphaltic concrete.

If the mineral aggregate does not meet the requirements of Subsection 414-3.01 of the specifications, no mix design will be prepared. The contractor shall take the necessary steps to provide material meeting the specified requirements.

Along with the samples furnished for mix design testing, the contractor shall submit a letter explaining in detail its methods of producing mineral aggregate including wasting, washing, blending, proportioning, etc., and

any special or limiting conditions it may propose. The contractor's letter shall also state the source(s) of mineral aggregate, the source and type of asphalt cement, the source and type of crumb rubber, and the source and type of mineral admixture.

Within 10 working days of receipt of all samples and the contractor's letter in the Central Laboratory, the Department will provide the contractor with a mix design containing the type and percentage of asphalt-rubber; the type and source of asphalt cement; the type and source of crumb rubber; the type, source, and percentage of mineral admixture; the source(s) of mineral aggregate and the percentage from each of the stockpile; the composite mineral aggregate gradation; the combined mineral aggregate and mineral admixture gradation; and any special or limiting conditions.

The contract time established for the completion of the work includes 10 working days for the required testing and developing of the approved mix design.

Asphaltic concrete friction course production shall not begin until there is an approved mix design.

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing mineral aggregate have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of the project.

414-5 Mix Design Revisions:

At any time after production of asphaltic concrete has been started using the approved mix design, changes may be proposed by the contractor or directed by the Engineer.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material

used for mix design purposes without approval of the Engineer, or without requesting a new mix design.

If the contractor elects to change its source or type of bituminous material, the type of mineral admixture, or the source(s) of mineral aggregate, or if the contractor adds or deletes the use of a mineral aggregate stockpile(s) regardless of source, testing to the extent deemed necessary by the Engineer will be performed in order that the Engineer may be satisfied that the mix design criteria will be met.

During production of asphaltic concrete, the contractor, on the basis of field test results, may request a change to the approved mix design. The Engineer will evaluate the proposed changes and notify the contractor of the Engineer's decision within two working days of the receipt of the request.

If, at any time, unapproved changes are made by the contractor in the source of bituminous material, source(s) of mineral aggregate, production methods, or proportional changes in violation of approved mix design stipulations, production shall cease until a new mix design is developed at no additional cost to the Department, or the contractor complies with the approved mix design.

At any time after the mix design has been approved, the contractor may request a new mix design. The costs associated with the testing of materials in the developing of mix designs requested by the contractor after a mix design acceptable to the Department has been developed shall be borne by the contractor.

If the Engineer determines that a new mix design is necessary due to changes in mineral aggregate characteristics or gradation, costs associated with the development of the new mix design shall be borne by the contractor.

A new mix design can be developed by the Engineer at any time the Engineer deems necessary. Should such a new mix design require revisions to the contractor's operations which result in additional cost to the contractor, it will be reimbursed for these costs. However, the Engineer reserves the right to modify the asphalt-rubber content without compensation being made to the contractor involving additional operation costs.

414-6 Acceptance of Materials:

414-6.01 General:

The contractor's attention is directed to the requirements of Subsection 105.13 of the specifications, Removal of Unacceptable and Unauthorized Work.

If the production of asphaltic concrete is stopped either for failure to meet the requirements specified in Subsection 414-6.03 of the specifications or because changes are made in the mix design, samples will be taken for calculating new consecutive averages either after production resumes or after the changes in the mix design have been made. The acceptance of the mineral aggregate gradation and the bituminous material content will be determined on the basis of the tests specified in Subsection 414-6.03 of the specifications. The Engineer reserves the right to increase the frequency of sampling and testing upon the resumption of asphaltic concrete production.

414-6.02 Mineral Aggregate:

Aggregate shall be free of deleterious materials, clay balls, and adhering films or other material that prevent thorough coating of the aggregate with the bituminous material.

Prior to and during asphaltic concrete production, the Engineer shall obtain and test samples of mineral aggregate for the determination of the sand equivalent, fractured coarse aggregate particles, and flakiness index. Samples shall be obtained either from the cold feed belt prior to the addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible. Should such testing indicate results not meeting the requirements of Table 414-2 for sand equivalent, fractured coarse aggregate particles, and flakiness index, operations shall cease and the contractor shall have the option of requesting a new mix design or correcting deficiencies in the aggregate stockpiles.

414-6.03 Asphaltic Concrete:

(A) Mineral Aggregate Gradation:

Prior to the initial startup of asphaltic concrete production, and prior to startup after any subsequent mix design revisions affecting gradation, a sample of the combined mineral aggregate shall be tested. The mineral aggregate shall meet the gradation requirements for the three-consecutive test limits indicated below. If the mineral aggregate does not meet these requirements, production shall not begin until the mineral aggregate is in compliance with this requirement.

For each approximate 500 tons of asphaltic concrete produced, at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of AASHTO R 90 on a random basis. For batch plants, the sample shall be taken from the hot bins. For other than batch plants, the sample shall be taken from the cold feed belt. Samples will be taken by means of a sampling device which is capable of obtaining representative samples. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphaltic concrete is less than 500 tons, at least one sample will be taken.

Samples will be tested for conformance to the mix design gradation, with or without mineral admixture as appropriate, in accordance with the requirements of AASHTO T 11 and AASHTO T 27.

The gradation will be considered to be acceptable unless the average of any three-consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests	
	Three Consecutive	One
No. 4	± 4	± 6
No. 8	± 3	± 4
No. 200	± 1.0	± 1.5

One hundred percent of the material shall pass the 3/8-inch sieve.

At any time that test results indicate that the gradation does not fall within all of the limits indicated, the production of asphaltic concrete shall cease immediately and shall not begin again until a calibration test indicates that the gradation is within the three-consecutive test limits indicated.

(B) Asphalt-Rubber Content:

During production of asphaltic concrete, the contractor shall maintain at the plant site a nuclear asphalt content gauge calibrated and operated in accordance with AASHTO T 287. At the discretion of the Engineer, the Department may choose to prepare the calibration samples for use by the contractor. Under the observation of the Engineer, the contractor shall determine the asphalt-rubber content by means of the nuclear asphalt content gauge a minimum of four times per full shift. The Engineer shall determine the times that the samples are taken. The contractor's technicians performing the testing, including the calibration of the nuclear gauge, shall meet the technician requirements given in Materials Practice and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

Production of asphaltic concrete shall cease immediately and the plant and/or the nuclear asphalt content gauges re-calibrated if any single test result varies by an amount greater than ± 0.60, or the average of three-consecutive test results varies by an amount greater than ± 0.40, from the amount directed by the Engineer. Material that has already been produced may be used on the project if the single test value representative of that material varies by an amount from ± 0.61 to ± 0.75, inclusive, from the amount directed by the Engineer. Material that has already been produced may not be used on the project if the single test value representative of that material varies by an amount greater than ± 0.75 from the amount directed by the Engineer unless, by retesting, the material is found to be acceptable.

414-6.04 Material Spread:

The estimated target spread rate will be as shown in the table in Subsection 414-3 of the specifications. The Engineer may adjust the estimated target spread rate, and establish a new target spread rate, as necessary to maintain a suitable thickness.

The thickness behind the screed shall be measured by the contractor continuously throughout each spread lot to ensure that the minimum compacted thickness specified in Subsection 414-3 of the specifications is being met.

A spread lot shall be considered to be one-half shift of production. The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, target spread rate, and tons placed in each spread lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the target spread rate.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A spread lot will be considered to be acceptable if the actual quantity placed does not vary by more than +5.0 percent from the required quantity.

414-7 Construction Requirements:

414-7.01 Quality Control:

Quality control of mineral aggregate production and asphaltic concrete production shall be the responsibility of the contractor. The contractor shall perform sufficient testing to assure that mineral aggregate and asphaltic concrete are produced which meet all specified requirements. The Engineer reserves the right to obtain samples of any portion of any material at any point of the operations for the Engineer's own use.

414-7.02 Stockpiling:

The contractor will not be allowed to feed the hot plant from stockpiles containing less than two full days of production unless only two days production remain to be done or special conditions exist where the Engineer deems this requirement waived.

Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

414-7.03 Proportioning, Drying, Heating, and Mixing:

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the specifications.

Unless approved by the Engineer, no individual mineral aggregate stockpile or hot bin usage shall be less than 3 percent of the total mineral aggregate.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless the collected fines are uniformly metered into the mixture.

The moisture content of the asphaltic concrete shall not exceed 0.5 percent. The moisture content will be determined in accordance with AASHTO T 329.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the dryer shall not exceed 350 degrees F.

414-7.04 Placing and Finishing:

(A) General Requirements:

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

All wheels and tires of compactors shall be wetted with water, or if necessary soapy water, or a release agent in order to prevent the sticking of asphaltic concrete. All other equipment surfaces shall be treated when necessary with a release agent. Only release agents evaluated through AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) are acceptable for use. The results from AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) testing, when tested in accordance with AASHTO T 383, shall conform to the requirements shown in the table below.

RELEASE AGENT TEST	REQUIREMENT
Asphalt Stripping Test Diluted Non-Diluted (Full Strength)	 No Stripping No Stripping
Asphalt Performance Test	Less than or equal to 10.0% after the third cycle

Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with bituminous material in accordance with the requirements of Section 404 of the specifications.

Unless otherwise specified on the project plans, asphaltic concrete shall not be placed on the 2-foot widened section where guardrail is to be installed.

(1) Placement Dates and Weather Requirements:

Asphaltic concrete shall be placed when the temperature of the surface on which the asphaltic concrete is to be placed is at least 85 degrees F and the ambient temperature at the beginning of placement is at least 70 degrees F and rising. The placement shall be stopped when the ambient temperature is 75 degrees F or less and falling. Night time placement may occur during falling temperature if the low temperature is 70 degrees F or higher.

No placement of asphaltic concrete shall occur if ambient temperatures are forecasted to be at or below 40 degrees F at any time during the day or night after placement.

No placement of asphaltic concrete shall occur if ambient temperatures exceed, or are forecasted to exceed, 110 degrees F the day before, the day of, or the day after paving.

No placement of asphaltic concrete shall occur if sustained wind speeds in excess of 15 miles per hour are forecast on the day of the scheduled placement. However, the Engineer may allow placement of asphaltic concrete during high wind conditions if the ambient temperature is 85 degrees F and rising.

No asphaltic concrete placement shall take place if rain occurs at any time in the two days prior to the scheduled placement of the asphaltic concrete, nor shall placement be expected to occur if rain is forecast during the proposed day of placement. However, at the discretion of the Engineer, placement may commence if actual conditions are conducive to placement.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

Unless otherwise directed by the Engineer, no traffic (including construction traffic, with the exception of required striping equipment) shall be allowed on the AR-ACFC overlay until at least eight hours after the placement of AR-ACFC. The Engineer may reduce this time for materials placed on ramps and auxiliary lanes, or for traffic related purposes. Prior to opening to any traffic, the Engineer may require up to three applications of lime water (a minimum of 50 pounds of lime per 2,000 gallons of water). Reasons may include, but are not limited to, opening prior to the eight-hour curing time, or ambient temperatures above 100 degrees F. Lime water shall be applied in a manner that uniformly covers the entire surface of the paving pass. No separate

payment will be made for lime water or its application, the cost being considered as included in this contract item.

The contractor shall prepare their bid submittal and initial construction schedule, submitted at the Preconstruction Conference as described in Subsection 108.03 of the specifications, based on the following beginning and ending dates for asphaltic concrete production.

Average Elevation of Project, Feet	Beginning and Ending Dates
0 – 3499	March 15 – May 31
0 – 3499	September 1 – October 31
3500 – 4999	April 15 – October 15
5000 – 5999	June 1 – September 15
6000 and over	June 1 – August 15

Any proposed placement deviating from the beginning and ending days shall be detailed in the written schedule of construction submitted at the weekly meeting described in Subsection 108.04 of the specifications. No contract time extension will be granted for placement outside of the beginning and ending dates. Any placement deviating from the beginning and ending dates shall be at the sole risk of the contractor.

(2) Delivery to Screed Unit:

Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps, or migration of the asphalt-rubber.

Should any one or more of such conditions be evident in the material delivered to the screed unit, and which cannot be eliminated by one or more of the following methods, the Engineer will order the work to be stopped until conditions are conducive to the delivery of the material in the condition as hereinbefore required:

(a) Covering hauling units with tarpaulins;

(b) Dumping material directly into the paver; and/or

(c) Moving the hot plant nearer to the point of delivery.

Other measures proposed by the contractor which will deliver asphaltic concrete meeting the above requirements will be considered by the Engineer.

(B) Loading Asphaltic Concrete into the Paving Machine:

If the asphaltic concrete is dumped directly into the paving machine from the hauling trucks, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the

paving machine by the trucks. Trucks, while dumping, shall be securely attached to the paving machine.

If the asphaltic concrete is dumped upon the surface being paved and subsequently loaded into the paving machine, it shall not be dumped at a distance greater than 150 feet in front of the paving machine. The loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphaltic concrete shall be picked up and loaded into the paving machine.

(C) Placing and Finishing Asphaltic Concrete by Means of Self-Propelled Paving Machines:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

In order to achieve, as far as practical, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective without tearing, shoving, or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required.

Tapered sections not exceeding 8 feet in width, or widened sections not exceeding 4 feet in width may be placed and finished by other means approved by the Engineer.

(D) Automatically Actuated Control System:

Except under certain conditions or at certain locations where the Engineer deems the use of automatic controls impractical, asphaltic concrete shall be placed and finished by means of self-propelled paving machines equipped with an automatically actuated control system.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly, either through controlling the transverse slope or, alternately when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with the following devices which shall be furnished with the machine:

(1) Ski-type device at least 30 feet in length, supported throughout its entire length; and

(2) Short ski.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

414-7.05 Joints:

Longitudinal joints shall be staggered a minimum of 1 foot with relation to the longitudinal joint of the immediate underlying course.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

Longitudinal joints shall be located within 1 foot of the centerline between two adjacent lanes.

414-7.06 Compaction:

(A) General Requirements:

The temperature of asphaltic concrete just prior to compaction shall be at least 275 degrees F.

The wheels of compactors shall be wetted with water, or if necessary soapy water, or a release agent approved in accordance with the requirements of Subsection 414-7.04 of the specifications, to prevent the asphaltic concrete from sticking to the steel wheels during rolling. Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent. The Engineer may change the rolling procedure if in the Engineer's judgment the change is necessary to prevent picking up of the asphaltic concrete.

(B) Equipment:

Compacting and smoothing shall be accomplished by the use of static steel wheel compactors. Vibrator compactors may be used in the static mode only. The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. A minimum of

three compactors shall be provided; however, sufficient compactors shall be provided so that the drums of the compactors when staggered will cover the entire width of the paving machine during initial breakdown.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

The compactors shall weigh not less than 8 tons.

(C) Rolling Procedure:

A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

Compaction shall consist of the following rolling sequence:

Rolling Sequence	Number of Coverages
Initial	1
Finish	1 - 2

A sufficient number of compactors shall be used for initial breakdown so that when the compactors are staggered the entire width of the mat being laid is compacted with one forward pass of the compactors. The distance between the paving machine and the initial rolling shall not exceed 300 feet.

A separate roller(s) shall be used for final compaction. The roller(s) used for final compaction shall follow as closely behind the initial breakdown rollers as possible.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated in accordance with the manufacturer's recommendations, and with the number of coverages of the compactors as specified.

414-7.07 Compacting Miscellaneous Items and Surfaces:

Asphaltic concrete used in the construction of miscellaneous items and surfaces shall be compacted using compactors, hot-hand tampers, smoothing irons, mechanical vibrating hand tampers, or with other devices to the extent considered necessary by the Engineer.

414-7.08 Smoothness and Surface Tolerances:

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance of Subsection 109.13 of the specifications.

Regardless of whether testing in accordance with Subsection 109.13 of the specifications is specified or not, the following requirements shall be met:

(A) The finished asphaltic concrete surface shall be tested and shall not vary by more than 1/8 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints; and

(B) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

414-7.09 Acceptance:

Asphaltic concrete will be accepted complete in place, if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no additional cost to the Department.

414-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, mineral admixture and asphalt-rubber. Measurement will include any weight used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt-rubber will be measured by the ton.

The weight of the asphalt-rubber material shall either be determined by weighing directly enroute from the reaction vessel to the point of delivery or be determined from the weight of the asphalt cement and the weight of the rubber minus wastage.

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 403-2 of the specifications.

414-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton, adjusted if necessary for spread, which price shall be full compensation for the work, complete in place, as specified herein.

If the quantity in a spread lot is found to vary by more than +5.0 percent from the required quantity, as determined in accordance with Subsection 414-6.04 of the specifications, no payment will be made for the material which exceeds the +5.0 percent, including asphalt-rubber and mineral admixture.

The Engineer may exclude asphaltic concrete from the spread lot if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

Payment for the asphalt-rubber will be made by the ton, including asphalt cement and crumb rubber. The results of a nuclear asphalt content gauge shall not be used to determine the weight of asphalt-rubber material as the basis of payment. Adjustments in payment shall be made in accordance with the requirements of Subsection 1009-2.03 of the specifications.

Mineral admixture will be paid for at the predetermined price established in the Bidding Schedule.

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13 of the specifications.

When lime water is used, no separate payment will be made for the lime water or its application, the cost being considered as included in this contract item.

SECTION 415 ASPHALTIC CONCRETE (ASPHALT-RUBBER) - END PRODUCT:

415-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete (Asphalt-Rubber), hereinafter asphaltic concrete, by providing a mix design meeting the design criteria specified herein, furnishing all materials, mixing at a plant, hauling, and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt-rubber) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications.

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design

criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

The contractor shall be responsible for all adjustments to its equipment necessary to properly accommodate the use of asphalt-rubber as a bituminous material.

415-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the contractor. Each mix design shall meet the criteria in Table 415-1.

TABLE 415-1
ASPHALTIC CONCRETE MIX DESIGN CRITERIA

Criteria	Requirements	Test Method
1. Voids in Mineral Aggregate, %, Minimum	19.0	ARIZ 832
2. Effective Voids, %, Range	5.0 ± 0.5	ARIZ 832
3. Absorbed Asphalt-Rubber, %, Range	0 - 1.0	ARIZ 832
4. Mix Design Grading Limits		AASHTO T 11, T 27
Sieve Size	**Percent Passing**	
	Without Admixture	**With Admixture**
3/4 inch	100	100
1/2 inch	80 - 100	80 - 100
3/8 inch	65 - 80	65 - 80
No. 4	28 - 42	29 - 43
No. 8	14 - 22	15 - 23
No. 200	0 - 2.5	0 - 3.5

415-3 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated as specified in the Special Provisions.

415-3.01 Mineral Aggregate Source:

The contractor shall provide a source in accordance with the requirements of Section 1001 of the specifications, except that sub-paragraph (3) under Subsection 1001-3.01(B) of the specifications shall not apply.

When the contractor selects a source or sources, it shall notify the Engineer. The contractor shall be solely responsible for assuring that the mineral aggregate meets all requirements and, when processed, is fully capable of providing asphaltic concrete which meets all the requirements of these specifications.

415-3.02 Mineral Aggregate:

Coarse and intermediate mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as mineral aggregate, so all crushing operations are inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the mineral aggregate has been crushed. Any material inspected by the Department as crushed material shall be separated from the contractor's other stockpiles and reserved for use throughout the project duration.

Mineral aggregate shall be separated into stockpiles by the contractor. No individual stockpile usage shall be less than 3 percent of the total mineral aggregate at any time during mix design or production. No individual stockpile shall contain more than 6.0 percent passing the No. 200 sieve when tested in accordance with AASHTO T 11 and AASHTO T 27. If necessary, the contractor shall wash the mineral aggregate to meet this requirement.

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt-rubber.

Mineral aggregate shall conform to the requirements in Table 415-2 when tested in accordance with the applicable test methods.

TABLE 415-2
MINERAL AGGREGATE CHARACTERISTICS

Characteristics	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity	Arizona Test Method 251	2.350 – 2.850
Combined Water Absorption	Arizona Test Method 251	0 – 2.5%
Sand Equivalent	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 4 material is required.)	Minimum 55
Uncompacted Void Content	AASHTO T 304 Method A	Minimum 45.0

TABLE 415-2 MINERAL AGGREGATE CHARACTERISTICS		
Fractured Coarse Aggregate Particles	AASHTO T 335	Minimum 85% (at least two fractured faces) and minimum 92% (at least one fractured face) determined on plus No. 4 material
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Carbonates (1)	Arizona Test Method 238	Maximum 20%

Notes:

(1) Testing for carbonates only applies if either of the following conditions exist:

(a) The asphaltic concrete is the designed final pavement surface normally used by traffic; and/or

(b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.

Tests on aggregates outlined in Table 415-2, other than abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on samples from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

Mineral aggregate from a source or combination of sources which does not meet the requirements given in Table 415-2 for combined bulk oven dry specific gravity, and/or combined water absorption (up to a maximum of 3.0 percent), but meets the other specified requirements will be considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt-rubber content and mineral admixture percentage, does not exceed the total amount bid for these items by more than 5.0 percent; or b) a supplemental agreement is executed adjusting the unit prices of asphaltic concrete components such that the total estimated cost does not exceed the total amount bid by more than 5.0 percent.

415-3.03 Mineral Admixture:

Mineral admixture will be required. The amount shall be 1.0 percent, by weight of the mineral aggregate. Mineral admixture shall be Portland cement, blended hydraulic cement, or hydrated lime, conforming to the requirements of Table 415-3.

TABLE 415-3
MINERAL ADMIXTURE

Material	Requirement
Portland Cement, Type I or, Type II	ASTM C150
Blended Hydrated Cement, Type IP	ASTM C595
Hydrated Lime	ASTM C1097

The certification and acceptance of Portland cement, blended hydraulic cement, and hydrated lime shall be in accordance with ADOT Materials Practice and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

415-3.04 Bituminous Material:

Bituminous material shall be asphalt-rubber conforming to the requirements of Section 1009 of the specifications. The type of asphalt-rubber shall be as specified in the Special Provisions. The crumb rubber gradation shall conform to the requirements of Section 1009 of the specifications.

The percent of asphalt-rubber used shall be based on the weight of total mix (asphalt-rubber, mineral aggregate, and mineral admixture).

In no case shall the asphalt-rubber be diluted with extender oil, kerosene, or other solvents. Any asphalt-rubber so contaminated will be rejected.

Any kerosene or other solvents used in the cleaning of equipment shall be purged from the system prior to any subsequent use of that equipment.

415-3.05 Blotter Material:

An application of blotter material may be required following the placement of the asphaltic concrete and prior to opening the roadway to traffic. The blotter material shall conform to the requirements of Section 404 of the specifications. The blotter material shall be applied in one or more applications for a total application of 2 pounds per square yard. The Engineer may reduce or eliminate blotter material if deemed to be unnecessary.

415-4 Mix Design:

Utilizing mineral aggregate which has been crushed, processed, separated, and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate samples used for mix design purposes shall be representative of aggregate materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement, crumb rubber, and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design engineer shall meet the requirements given in ADOT Materials Practice and Procedure Directive No. 4, “Asphaltic Concrete Mix Design Proposals and Submittals”. The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Practice and Procedure Directive No. 19, “ADOT System for the Evaluation of Testing Laboratories”.

The contractor may propose the use of a mix design that has been developed for a previous project. The proposed mix design shall meet the requirements of these specifications. The contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing mineral aggregate, have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of that project.

The mix design shall contain as a minimum:

(A) The name and address of the testing organization and the person responsible for the mix design testing;

(B) The specific location(s) of the source(s) of mineral aggregate;

(C) Asphalt-rubber design, including asphalt cement type and source; crumb rubber type, gradation, and source; percent crumb rubber by weight of asphalt cement; asphalt cement binder properties; asphalt-rubber binder properties; blending procedures; and reaction time;

(D) The anticipated mineral aggregate gradation in each stockpile;

(E) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture; and

(F) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, uncompacted void content, percent carbonates (if required), asphalt-rubber absorption, percent air voids, voids in mineral aggregate, and bulk density.

Test results used in the formulation of the mix design shall be from testing performed no earlier than 45 days prior to the date the mix design is signed by the mix design engineer. Historical abrasion values may be supplied on sources, provided the testing was conducted within the past two years.

The mix design shall be submitted to the Engineer under a cover letter signed by an authorized representative of the contractor.

At least five working days prior to the start of asphaltic concrete production, the contractor shall provide the Engineer with samples of the asphalt cement, crumb rubber, and asphalt-rubber that are representative of the materials to be used during production. Asphaltic concrete production shall not begin until the Engineer determines the acceptability of the proposed asphalt cement, crumb rubber, and asphalt-rubber.

A copy of the mix design and representative samples of the materials used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and for the determination of sand equivalent, fractured coarse aggregate particles, and uncompacted void content. Approximately 300 pounds of mineral aggregate (proportional to the mix design gradation), 3 gallons of asphalt-rubber, and 1 gallon of mineral admixture shall be submitted. The Engineer shall witness the sampling of the mineral aggregate. The mix design and samples shall be submitted to the Engineer at least five working days prior to the start of asphaltic concrete production.

The sand equivalent, fractured coarse aggregate particles, and uncompacted void content shall meet the requirements specified in Subsection 415-3.02 of the specifications. Additional testing of the fine aggregate for uncompacted void content will be required if the method of producing fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information, for further action and resubmission by the contractor.

If the contractor elects to change its source(s) of mineral aggregate, or adds or deletes the use of a stockpile(s) regardless of source, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

If changes are made in the source or type of bituminous material, or the type of mineral admixture, the contractor shall provide verification testing results. Verification testing shall be performed at the original mix design asphalt content using the original mineral aggregate, the proposed bituminous material, and/or the proposed mineral admixture. Three specimens shall be fabricated and tested for bulk density, maximum theoretical density, and effective voids. The percent effective voids must be within ± 0.2 of the percent effective voids in the original design and also be within the current effective voids mix design specification limits. Verification testing results shall not replace target values shown in the original mix design. All target values from the original design shall be used in future production with the exception of any self-directed target value changes that are requested. The verification process does not ensure that the contractor can meet the target values during production.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. Self-directed target changes shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size):	
3/8 inch	±4% from mix design target value
No. 4	±4% from mix design target value
No. 8	±4% from mix design target value
Asphalt-Rubber Content	±0.2% from mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

In no case shall the approval of mix design changes relieve the contractor of the responsibility for the results obtained by the use of such approved changes.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer or without preparing a new mix design.

If at any time unapproved changes are made in the source of bituminous material, source(s) of mineral aggregate, production procedures, or proportional changes in violation of approved mix design stipulations, production shall cease until a new mix design is developed, or the contractor complies with the approved mix design.

415-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) of the specifications. At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed.

(A) Aggregate production, including crusher methods, pit extraction, and washing;

(B) Stockpile management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention;

(C) Proportioning and plant control, including plant scale calibration, mix temperature control, storing method, and addition of admixture;

(D) Transporting and placing, including hauling distance and temperature control, segregation and non-uniform placement control, and joint placement and technique; and

(E) Compaction, including types and weight of rollers, establishing and monitoring of roller patterns, and temperature controls.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	**TEST METHOD**	**SAMPLING POINT**	**MINIMUM TESTING FREQUENCY**
Mineral Aggregate for Asphalt Concrete			
Gradation	AASHTO T 11, T 27	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176	Crusher Belt or Stockpile	1 per 2,000 Tons of total aggregate (1)
Fractured Coarse Aggregate Particles	AASHTO T 335		
Uncompacted Void Content	AASHTO T 304 Method A		
Asphaltic Concrete End-Product			
Gradation	AASHTO T 11, T 27, T 308	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1,000 Tons
Asphalt-Rubber Content	AASHTO T 287, T 308, or other approved methods	Roadway or Plant	1 per 1,000 Tons
Voids	AASHTO R 68, T 166, T 029, T 245, T 269	Roadway or Plant	1 per 1,000 Tons each day. Maximum of 4 per day.
Compaction	AASHTO T 355	Roadway	1 per 300 Tons

Note:

(1) Prior to the completion of the mix design, quality control tests on mineral aggregate shall be performed based on the anticipated percent use of each stockpile. Samples taken from individual stockpiles may be composited prior to performing the required tests, or testing may be performed on material from each stockpile and the composite test result for each required test determined mathematically.

415-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading, and finishing of asphaltic concrete, and for the applying of bituminous material, such as tack coats, prime coats, and provisional seals, all in accordance with the appropriate portions of the specifications.

The contractor shall be responsible for the material spread rate and thickness control.

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the specifications.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 350 degrees F.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which shall distribute the mixture uniformly in front of adjustable screeds.

Pavers shall be equipped with a screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

Prior to opening to any traffic, the Engineer may require an application of lime water (a minimum of 50 pounds of lime per 2,000 gallons of water). Lime water shall be applied in a manner that uniformly covers the entire surface of the paving pass. No separate payment will be made for lime water or its application, the cost being considered as included in this contract item.

All wheels and tires of compactors shall be wetted with water, or if necessary soapy water, or a release agent in order to prevent the sticking of asphaltic concrete. All other equipment surfaces shall be treated when necessary with a release agent. Only release agents evaluated through AASHTO Product Evaluation & Audit Solutions

(formerly NTPEP) are acceptable for use. The results from AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) testing, when tested in accordance with AASHTO T 383, shall conform to the requirements shown in the table below.

RELEASE AGENT TEST	REQUIREMENT
Asphalt Stripping Test Diluted Non-Diluted (Full Strength)	 No Stripping No Stripping
Asphalt Performance Test	Less than or equal to 10.0% after the third cycle

Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Longitudinal joints of each course shall be staggered a minimum of 1 foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on 10 foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately 1 foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within 1 foot of the center of a lane or within 1 foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by and acceptable to the Engineer.

A light coat of bituminous material shall be applied to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps, or migration of the asphalt-rubber. Should any one or more of such conditions be evident in the material delivered to the screed unit, the Engineer will order the work to be stopped until conditions are conducive to the delivery of the material in the condition as hereinbefore required.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with AASHTO T 329.

415-7 Acceptance of Materials:

415-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests performed on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

(A) Sand equivalent;
(B) Fractured coarse aggregate particles;
(C) Uncompacted void content;
(D) Gradation;
(E) Asphalt-rubber content;
(F) Effective voids;
(G) Material spread;
(H) Compaction; and
(I) Smoothness

415-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate:

During asphaltic concrete production, the Engineer shall obtain and test samples of mineral aggregate for the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content. Samples shall be obtained from the cold feed belt prior to the addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible.

Mineral aggregate will be acceptable for sand equivalent if it meets the minimum requirements specified in Subsection 415-3.02 of the specifications.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 415-3.02 of the specifications.

The uncompacted void content shall meet the minimum requirements specified in Subsection 415-3.02 of the specifications. Additional testing of the fine aggregate for uncompacted void content will be required if the method of producing fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 415-4 of the specifications or correcting deficiencies in the aggregate stockpiles.

415-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 415-9(D) of the specifications.

The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date, and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, and tons placed in each lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the mix design bulk density unless a request is made by the contractor to use a production bulk density. If a request is made to use production bulk density, the first three non-rejected lots following the test lot will be used to determine the average production bulk density. All lots placed prior to establishing the average production bulk density shall be calculated using the mix design bulk density. For each new mix design used on the project, a new production bulk density may be requested by the contractor. In addition, if conditions warrant during asphalt

production, the contractor may request establishment of a new average production bulk density. All requests to use a production bulk density shall be made in writing and approved by the Engineer prior to use. The same procedure will be used for determining average production bulk density in all cases. Changes to the bulk density for calculating spread quantities will not be retroactive.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A lot will be considered to be acceptable, with a zero pay factor, if the actual quantity placed varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary from the required quantity by -2.1 to -12.0 percent, the appropriate pay factor will be determined in accordance with Table 415-4. This pay factor will be utilized in determining the pay adjustment as outlined in Subsection 415-9 of the specifications.

415-7.04 Gradation, Asphalt-Rubber Content, and Effective Voids:

A mixture properties lot shall be considered to be one shift's production. In the event a shift's production is less than 1,200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix design or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples will be taken in accordance with the requirements of Section 2 or 3 of AASHTO R 97. The samples shall be delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 75 pounds. The Engineer will split the sample and save one-half for 15 days after written notification to the contractor of test results for that lot has been made. The material will be tested by the Engineer for the following properties:

Test Property	Test Method
Asphalt-Rubber Content	AASHTO T 308 (See Notes 1 and 2 below)
Gradation	
Marshall Density	AASHTO R 68, T 245
Maximum Theoretical Density	AASHTO T 209
Effective Voids	AASHTO T 269

Notes:

(1) A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs.

(2) Ignition furnace results for asphalt-rubber content will be corrected in accordance with the paragraph below as required.

For plants providing asphaltic concrete exclusively for the project, the difference between the asphalt-rubber content as measured by ignition furnace testing and the actual asphalt-rubber content shall be determined by the Engineer for each of the first five lots of asphaltic concrete produced for each mix design. If there are less than five lots for the mix design, the total number of available lots shall be used. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt-rubber tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt-rubber content may include invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration of the mass-flow meter be performed. If the average difference exceeds $\pm$ 0.10 percent asphalt-rubber content between the asphalt-rubber content measured by ignition furnace testing and the actual asphalt-rubber content, the contractor may request that a correction to the asphalt-rubber content by ignition furnace testing be made. The contractor must make such a request in writing within two working days after receiving the test results for the fifth lot of asphaltic concrete production. If referee testing is performed on a lot of asphaltic concrete for which a correction, based on the actual asphalt-rubber content, was made to the asphalt-rubber content by ignition furnace testing, referee testing shall not apply to the determination of asphalt-rubber content. The correction, once documented and approved by the Engineer, shall be applied to test results from the beginning of asphaltic concrete production through the remainder of asphaltic concrete production using that mix design; however, a new correction may be determined at any time the Engineer believes it is necessary due to a change in material or other circumstances. If the contractor submits a new mix design, a new correction must be established and applied as specified above. For other plants, no correction will be made to asphalt-rubber content values measured by ignition furnace testing.

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

The target values for gradation, asphalt-rubber content, and effective voids are given in the contractor's mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics		
Gradation (sieve size):	**LL**	**UL**
3/8-inch	TV – 6.0	TV + 6.0
No. 4	TV – 6.0	TV + 6.0
No. 8	TV – 6.0	TV + 6.0
No. 200	TV – 2.0	TV + 2.0
Asphalt-Rubber Content	TV – 0.60	TV + 0.60
Effective Voids	TV – 2.0	TV + 2.0
Note: (1) The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the applicable target value (TV).		

The Engineer will determine the PT for each measured characteristic in accordance with Subsection 415-9(I) and utilizing Table 415-4 of the specifications will determine the pay factor for each measured characteristic.

In the event the contractor elects to question the mixture property test results, the contractor may request referee testing in accordance with Subsection 415-9(J) of the specifications.

415-7.05 Compaction:

Asphaltic concrete shall only be placed when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F and the ambient temperature is at least 65 degrees F and rising. The placement shall be stopped when the ambient temperature is at or below 70 degrees F and falling.

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractor's responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled by methods approved by the Engineer, while the mixture is still hot.

A compaction lot shall be identical to the mixtures properties lot described in Subsection 415-7.04 of the specifications. Lots encompassing more than one project shall be separated in accordance

with Subsection 415-9(D) of the specifications. Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. Cores shall be taken using wet coring with soapy water to aid in the release of the core from the coring equipment. The Engineer will designate ten random locations within the lot and the contractor shall take two cores at each location; however, if more than one shift constitutes a lot, two cores shall be taken from a minimum of two random locations each shift, or as directed by the Engineer. The Engineer will save one core from each location for 15 days after written notification to the contractor of test results for that lot has been made. Randomly selected locations will be determined to the nearest 0.5 foot in the transverse direction and to the nearest 1 foot in the longitudinal direction of the pavement course; however, the outside 1 foot of the unconfined pavement course will be excluded from testing as shown in ADOT Materials Practice and Procedure Directive (P.P.D.) No. 18, "Determining Sample Times and Locations for End Product Asphaltic Concrete". P.P.D. No. 18 also addresses areas to be excluded relative to longitudinal joints. Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of AASHTO R 97. Cores shall be a minimum of 4 inches in diameter and shall be taken not later than two working days after placement of the asphaltic concrete. The cores shall be delivered to the Engineer immediately upon being taken. The bulk density of each core will be determined by the Engineer in accordance with the requirements of AASHTO T 166. The test results will be furnished to the contractor within four working days of receipt of cores by the Engineer.

The target value for compaction shall be 7.0 percent in-place air voids. In-place air voids shall be determined in accordance with AASHTO T 269. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 415-7.04 of the specifications.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 3.5 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 415-9(I) and utilizing Table 415-4 of the specifications will determine the compaction pay factor.

In the event the contractor elects to question the core test results, the contractor may request referee testing in accordance with Subsection 415-9(J) of the specifications.

415-7.06 Smoothness and Surface Tolerances:

All courses of asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13 of the specifications.

Regardless of whether testing in accordance with Subsection 109.13 of the specifications is specified or not, the following requirements shall be met:

(A) The surface of the final lift of asphaltic concrete placed under this section of the specifications shall be tested and shall not vary by more than 1/8 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints;

(B) The surface of any lift of asphaltic concrete placed under this section of the specifications, other than the final lift, shall be tested and shall not vary by more than 1/4 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints; and

(C) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

415-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt-rubber, and mineral admixture. Measurement will include any quantity used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt-rubber will be measured by the ton on the basis of the asphalt-rubber content determined in accordance with Subsection 415-7.04 of the specifications for each lot of asphaltic concrete accepted. The average asphalt-rubber content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt-rubber. If the contractor has requested referee testing, the average asphalt-rubber content will come from the independent testing laboratory results, unless a correction, based on the actual asphalt-rubber content, was made to the ignition furnace test value as allowed in Subsection 415-7.04 of the specifications. If a correction, based on the actual asphalt-rubber content, was made to the ignition furnace test value, the average asphalt-rubber content determined from the Department's acceptance testing will be used. At the discretion of the Engineer, asphalt-rubber may be measured by invoice quantities, adjusted as necessary for waste. Waste generated from startup of the asphalt plant will be considered to have a binder content of 3.0 percent. In no case

shall the measured amount of asphalt-rubber for payment be greater than the total of the invoice quantities, adjusted for waste.

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 403-2 of the specifications.

415-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate pay factors as hereinafter provided.

For the purpose of determining acceptability and appropriate pay factors, each unit of asphaltic concrete will be included in three separate lots: a "spread lot", a "mixture-properties lot", and a "compaction lot". The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor.

The contractor may request to place the first lot of each mix type as a test strip. Requests to place a test strip shall be made in writing and acknowledged by the Engineer prior to start of production. A test strip shall be limited to 1,000 tons and may only be placed on shoulders, ramps, cross roads, or other areas approved by the Engineer. A test strip shall be excluded from the mixture properties lot pay factor and the compaction lot pay factor; however, all other provisions of Subsection 415-9 of the specifications shall still apply to such areas.

The Engineer may exclude asphaltic concrete from the spread lot and from the spread lot pay factor calculations if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

The Engineer may exclude certain locations from the mixture properties lot and/or the compaction lot and from the random sampling used in determining the mixture properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

When lime water is used, no separate payment will be made for the lime water or its application, the cost being considered as included in this contract item.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 415-7.03 of the specifications. If the quantity in a spread lot is found to vary by more than +5.0 percent from the required quantity, no payment will be made for the material which exceeds +5.0 percent, including asphalt cement and mineral admixture. If the quantity is found

to vary by more than -12.0 percent from the required quantity, the spread lot will be rejected.

(B) Mixture Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

(1) The individual PT values and pay factors for Gradation, Asphalt-Rubber Content, and Effective Voids shall be determined as set forth in Subsection 415-7.04 of the specifications;

(2) A single pay factor shall be determined for Gradation, and Asphalt-Rubber Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt-Rubber Content; and

(3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed $3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 415-9(E) of the specifications shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be determined as set forth in Subsection 415-7.05 of the specifications.

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor, mixture properties lot pay factor, and compaction lot pay factor for each project shall be determined as follows:

(1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 415-7.03 of the specifications;

(2) The individual PT values and pay factors for Gradation, Asphalt-Rubber Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 415-7.04 of the

specifications, regardless of which project(s) the samples fall within;

(3) PT values and pay factors for compaction shall be determined from separate sets of core samples for each project;

(4) The mixture properties lot pay factor shall be determined separately for each project in accordance with Subsection 415-9(B) of the specifications, utilizing the individual pay factors determined in (2) above; and

(5) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 415-9(C) of the specifications, utilizing the pay factor determined in (3) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt-Rubber Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within 15 days after receiving notice that a spread lot, mixture properties lot, or compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus $1.00 per ton for spread lots, minus $5.00 per ton for compaction lots, minus $3.00 per ton for mixture properties lots in reject for gradation only, minus $5.00 per ton for mixture properties lots in reject for asphalt-rubber content and/or effective voids only, and minus $5.00 per ton for mixture properties lots in reject for asphalt-rubber content and/or effective voids and also gradation. Positive mixture properties lot pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place. In addition, for any mixture properties lot that is in reject due to asphalt-rubber content but allowed to remain in place, payment shall not be made for asphalt-rubber quantities in excess of the upper limit (UL) as determined in Subsection 415-7.04(A) of the specifications.

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by an independent professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected mixture properties lot or a rejected compaction lot is submitted for referee testing by the

contractor, the 15 days allowed to prepare an engineering analysis will begin upon notification of referee test results.

The contractor may submit a written proposal without an engineering analysis for Engineer's evaluation and approval, that a mixture properties lot with a PT value lower than 50 on gradation and/or asphalt cement content be allowed to remain in place if the application of a Self-Directed Target Change as outlined in Subsection 415-4 of the specifications would bring the PT value to 50 or greater. This written request shall also include the proposed revised PT calculations. Upon Engineer's verification and approval of the request, the material shall remain in place at the maximum negative pay factor(s) specified in this Subsection for the mixture properties lot in reject.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factor(s), and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

(1) The occurrence of two or more rejected lots within any ten consecutive production lots;

(2) The occurrence of three consecutive negative mixture properties lot pay factors or three consecutive negative compaction lot pay factors; and/or

(3) The occurrence of five or more pay factors that are negative either for a mixture properties lot or for a compaction lot within any ten consecutive production lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 415-4 of the specifications, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design, or the course of action proposed in the engineering analysis, shall be implemented, and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt-Rubber:

Payment for asphalt-rubber will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Section 1009 of the specifications.

(G) Mineral Admixture:

Mineral admixture will be paid for at the predetermined price established in the Bidding Schedule.

(H) Smoothness:

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13 of the specifications.

(I) Statistical Acceptance:

The "Total Percentage of Lot Within UL and LL (PT)" shall be determined in accordance with Subsection 109.11 of the specifications.

Pay Factors (PF) shall be determined by entering Table 415-4 with PT.

TABLE 415-4
PAY FACTORS

Material Spread		Mixture Properties and Compaction			
			Pay Factors (Dollar per Ton)		
Negative Variance %	Pay Factor (Dollars per Ton)	PT	Gradation and Asphalt-Rubber Content	Effective Voids	Compaction
2.1- 3.0	- 0.10	100	0.00	+ 2.00	+ 2.00
3.1- 4.0	- 0.20	95-99	0.00	+ 0.50	+ 0.50
4.1- 5.0	- 0.30	90-94	0.00	0.00	0.00
5.1- 6.0	- 0.40	85-89	0.00	- 0.25	- 0.25
6.1- 7.0	- 0.50	80-84	- 0.25	- 0.50	- 0.50
7.1- 8.0	- 0.60	75-79	- 0.50	- 0.75	- 0.75
8.1- 9.0	- 0.70	70-74	- 0.75	- 1.00	- 1.00
9.1- 10.0	- 0.80	65-69	- 1.00	- 1.25	- 1.25
10.1- 11.0	- 0.90	60-64	- 1.50	- 1.50	- 1.75
11.1- 12.0	- 1.00	55-59	- 2.00	- 2.00	- 2.25
More than 12.0	Reject	50-54	- 2.50	- 2.50	- 3.00
See Subsections 415-9(A) and (E)		Less than 50	Reject – See Subsection 415-9(E)		

(J) Referee Testing:

(1) Referee Testing Performed for Mixture Properties Only:

Within 15 days after written notification to the contractor of test results for a particular mixture properties lot, the contractor may make a written request for referee testing. The referee testing shall be performed by an independent approved laboratory designated by the Department. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the test results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for the following properties:

Test Property	Test Method
Asphalt-Rubber Content (See Note 1)	AASHTO T 308
Gradation	
Marshall Density	AASHTO R 68, T 245
Maximum Theoretical Density	AASHTO T 209
Effective Voids	AASHTO T 269
Note: (1) If a correction to the asphalt-rubber content by ignition furnace testing is made in accordance with Subsection 415-7.04 of the specifications, the asphalt-rubber content shall not be subject to referee testing.	

The results of the referee testing will be binding on both the contractor and the Department.

Using the referee testing results, the Engineer will determine new PT's for all characteristics, with the exception of asphalt-rubber content if a correction to the ignition furnace value was made as specified in Subsection 415-7.04 of the specifications.

When referee testing is performed on a mixture properties lot, the referee test result for the average maximum theoretical density will be used to determine a new PT for compaction.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties of that particular lot.

(2) Referee Testing Performed for Compaction Only:

Within 15 days after written notification to the contractor of test results for a particular compaction lot, the contractor may make a written request for referee testing. The bulk density of each of the cores previously saved will be determined in accordance with the requirements of AASHTO T 166 by an independent testing laboratory designated by the Department. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, or the test results by the Department. The percent air voids will be determined in accordance with AASHTO T 269. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 415-7.04 of the specifications.

The results of the referee testing will be binding on both the contractor and the Department.

When referee testing is performed on the compaction lot, the Engineer will determine a new PT for compaction using the referee testing results.

The Department will pay for the referee testing; however, if the pay factor of the compaction lot does not improve or is reduced, or the compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete will be reduced by the amount of the cost of referee testing for the compaction of that particular lot.

(3) Referee Testing Performed for Both Mixture Properties and Compaction:

When referee testing is performed, as described above, for both the mixture properties lot and the compaction lot, the Engineer will use the referee test results to determine new PT's as specified in Subsections 415-9(J)(1) and 415-9(J)(2) of the specifications.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties and compaction of that particular lot.

SECTION 416 ASPHALTIC CONCRETE - END PRODUCT:

416-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete-End Product, hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt cement)

to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications.

Reclaimed asphalt pavement (RAP), as defined in Subsection 416-3.04 of the specifications, may be used in the mixture provided all requirements of the specifications are met. References to the use of RAP in this section apply only if RAP is utilized as part of the mixture. ADOT Materials Practice and Procedure Directive No. 20, “Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete”, shall be used in conjunction with the requirements of the specifications.

Warm Mix Asphalt (WMA) technologies may be used in the mixture at the option of the contractor provided all requirements of the specifications are met. WMA is defined as asphaltic concrete that is produced within the temperature range of 215 to 275 degrees F. WMA can be produced by one or a combination of several WMA technologies including plant water foaming processes, mineral additives, and chemical additives. The requirements for incorporating WMA technologies in the mixture are given in these specifications and in Materials Practice and Procedure Directive No. 23, “Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete”.

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

416-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed utilizing a minimum ratio of three (3) for the lift thickness to nominal maximum aggregate size.

Mix designs shall be developed by the contractor on the basis of the following criteria and tested in accordance with the requirements of the following test methods:

Criteria	Requirements			Arizona Test Method / AASHTO
	1/2" Mix	3/4" Mix	Base Mix	
1. Voids in Mineral Aggregate: %, Range	15.5 - 18.5	15.0 - 18.0	14.5 - 17.0	Note (2)
2. Effective Voids: %, Range	4.0 ± 0.2	4.0 ± 0.2	4.0 ± 0.2	Note (2)
3. Absorbed Asphalt: %, Range	0 - 1.0	0 - 1.0	0 - 1.0	Note (2)
4. Index of Retained Strength: %, Minimum	60 (Note 1)	60 (Note 1)	60 (Note 1)	Note (3)
5. Wet Strength: psi, Minimum	150	150	150	Note (3)
6. Stability: pounds, Minimum	2,000	2,000	3,000	Note (2)
7. Flow: 0.01-inch, Range	8 - 16	8 - 16	8 - 16	Note (2)
8. Mix Design Grading Limits				AASHTO T 11, T 27

Sieve Size	Percent Passing					
	1/2 inch Mix		3/4 inch Mix		Base Mix	
	Without Admix.	With Admix.	Without Admix.	With Admix.	Without Admix.	With Admix.
1-1/4 inch					100	100
1 inch			100	100	90 -100	90 - 100
3/4 inch	100	100	90 - 100	90 - 100	85 - 95	85 - 95
1/2 inch	90 - 100	90 - 100	---	---	---	---
3/8 inch	67 - 82	67 - 82	62 - 77	62 - 77	57 - 72	57 - 72
No. 8	40 - 48	41 - 49	37 - 46	38 - 47	32 - 42	33 - 43
No. 40	10 - 18	11 - 19	10 - 18	11 - 19	8 - 16	9 - 17
No. 200	1.5 - 4.5	2.5 - 6.0	1.5 - 4.5	2.5 - 6.0	1.5 - 3.5	2.5 - 5.0

Notes:

(1) If the average elevation of the project is above 3,500 feet, the index of retained strength shall be a minimum of 70 percent.

(2) For mixes without RAP, Arizona Test Method 815. For mixes with RAP, Arizona Test Method 833.

(3) For mixes without RAP, Arizona Test Method 802 (as modified by Arizona Test Method 815). For mixes with RAP, Arizona Test Method 802 (as modified by Arizona Test Method 833).

The ratio of the mix design composite gradation target for the No. 200 sieve, including mineral admixture, to the effective asphalt content shall be within the range 0.7 to 1.3.

416-3 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated as specified in the Special Provisions.

416-3.01 Mineral Aggregate:

(A) General:

Mineral aggregate shall consist of virgin aggregate, or a combination of virgin aggregate and aggregate from RAP (RAP aggregate). When the terms “mineral aggregate” or “aggregate” are used without being further described as “virgin” or “RAP”, the intended meaning is the total aggregate material used in the mixture.

No individual stockpile or hot bin usage of either virgin aggregate or RAP aggregate shall be less than 3 percent of the total mineral aggregate.

(B) Virgin Mineral Aggregate:

The contractor shall provide a source in accordance with the requirements of Section 1001 of the specifications.

Coarse virgin mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

For areas or applications where Special Mix is not called for on the plans, fine virgin mineral aggregate shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

For areas or applications where Special Mix is called for on the project plans, the following shall apply:

Fine virgin mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as virgin mineral aggregate, so all crushing operations can be inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the virgin mineral aggregate has been crushed. Any material inspected by the Department as crushed material for the project shall be separated from the contractor's other stockpiles and reserved for use throughout the project duration.

The contractor may blend uncrushed fine virgin aggregate up to a maximum of 15 percent of the total aggregate for mixes not containing RAP, or up to a maximum of 10 percent of the total aggregate for mixes containing RAP. The total composite of virgin fine aggregate shall meet

the requirement for uncompacted void content. The uncrushed fine virgin aggregate shall be 100 percent passing the 1/4 inch sieve and contain not more than 4.0 percent passing the No. 200 sieve. Should the contractor modify the method of producing either the uncrushed or crushed fine aggregate, the Engineer shall be immediately notified and the materials sampled and tested for determination of uncompacted void content.

(C) RAP Mineral Aggregate:

RAP aggregate shall conform with Materials Practice and Procedure Directive No. 20 “Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete”.

(D) Mineral Aggregate Characteristics:

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity (1)	Arizona Test Method 251	2.350 - 2.850
Combined Water Absorption (1)	Arizona Test Method 251	0 - 3.0%
Sand Equivalent (1)	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 4 material is required.)	Minimum 55
Abrasion (2)	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%
Fractured Coarse Aggregate Particles (3)	AASHTO T 335	Minimum 70% (4) (at least one fractured face, determined on plus No. 4 material)
Uncompacted Void Content (1) (Special Mix Only)	AASHTO T 304 Method A	Minimum 45%
Carbonates (3) and (5)	Arizona Test Method 238	Maximum 20%

Notes:

(1) When the mix design contains RAP, the requirements shall be for the virgin aggregate portion only.

(2) Abrasion shall be performed separately on materials from each source of mineral aggregate, including RAP aggregate. All sources shall meet the requirements for abrasion.

(3) When the mix design contains RAP, the requirements shall be for the composite of virgin and RAP aggregate.

(4) When Special Mix is called for on the project plans, this value shall be minimum 85% with at least two fractured faces and minimum 92% with at least one fractured face, determined on plus No. 4 material.

(5) Testing for carbonates only applies if either of the following conditions exist:

(a) The asphaltic concrete is the designed final pavement surface normally used by traffic.

(b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. When RAP is used in the mixture, RAP aggregates for testing shall be obtained from the RAP material using Method A of AASHTO T 164, prior to combining with the virgin aggregate.

416-3.02 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate, unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for Wet Strength and Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either Portland cement, blended hydraulic cement or hydrated lime conforming to the following requirements.

Material	Requirement
Portland Cement, Type I, or Type II	ASTM C150
Blended Hydraulic Cement, Type IP or IL	ASTM C595
Hydrated Lime	ASTM C1097

The certification and acceptance of Portland cement, blended hydraulic cement, and hydrated lime shall be in accordance with ADOT Materials Practice and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

416-3.03 Bituminous Material:

(A) General:

Bituminous material shall consist of performance grade (PG) asphalt binder (virgin binder), or a combination of virgin binder and binder from RAP (RAP binder). When the terms “bituminous material”, “asphalt cement”, “asphalt binder”, or “binder” are used without being further described as “virgin” or “RAP”, the intended meaning is the total bituminous material used in the mixture.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

(B) Virgin Bituminous Material:

Virgin asphalt cement shall be a performance grade (PG) asphalt binder, conforming to the requirements of Section 1005 of the specifications. The type of virgin asphalt binder shall be as specified in the Special Provisions. If RAP is used in the mixture, the virgin asphalt binder shall be as required to meet the blending requirements in Subsection 416-3.03(C) of the specifications and Arizona Test Method 833.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.17 ± 0.02 Pascal·seconds, measured in accordance with AASHTO T 316. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.28 ± 0.03 Pascal·seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 degrees F and 350 degrees F, and a viscosity-temperature curve developed in accordance with ASTM D2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 degrees F or a maximum laboratory compaction temperature exceeding 300 degrees F, the laboratory mixing and compaction temperature ranges shall be specified in writing by the virgin asphalt binder supplier. A viscosity-temperature curve will meet this requirement for written documentation if the viscosity-temperature curve is developed and submitted by the binder supplier and includes language that the recommended laboratory mixing and compaction temperatures are within acceptable ranges, and the submittal includes a statement indicating the maximum laboratory mixing temperature to which the

binder can be heated without damage. The laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used, shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report. The laboratory mixing and compaction temperatures are for mix design purposes only. Field mixing and compaction temperatures are specified in Subsections 416-6 and 416-7 of the specifications.

(C) RAP Bituminous Material:

RAP binder content shall be determined by AASHTO T 308. RAP binder shall consist of the asphalt binder portion of the reclaimed asphaltic pavement. A maximum of 30 percent RAP binder, by weight of total binder in the mix, may be used in mixes placed in a lower lift (minimum 2 inches below finished surface). A maximum of 24 percent RAP binder, by weight of total binder in the mix, may be used at all other locations.

When less than or equal to 17 percent RAP binder is used, by weight of total binder in the mix, no testing is required on the RAP binder. When greater than 17 percent RAP binder is used, by weight of total binder in the mix, the RAP binder shall be extracted, recovered, and tested in accordance with the requirements of Arizona Test Method 833. The virgin binder grade shall be modified if necessary to ensure the blend of virgin and RAP binder meets the PG grade specified in the Subsection 416-3.03(B) of the specifications. However, a change of only one virgin PG binder grade (6 degrees C on either or both the high and low temperatures) will be allowed from that shown in Subsection 416-3.03(B) of the specifications.

416-3.04 Reclaimed Asphalt Pavement (RAP):

RAP shall consist of salvaged, milled, pulverized, broken, or crushed asphalt pavement. If RAP is generated by milling, the minimum removal depth shall be 1-1/2 inches. The source of RAP may be from ADOT or other projects. The contractor shall be responsible for determining the suitability of the RAP for use in the mixture, regardless of its source.

RAP material shall pass the 1-1/4 inch sieve. For asphaltic concrete containing greater than 17 percent RAP aggregate, as determined by Ignition Furnace AASHTO T308, the RAP material shall be processed by one of the following: RAP material shall pass the 1-1/4 inch sieve and be fractionated into uniform coarse and fine stockpiles such that there will be a minimum amount of fines or formation of a single uniform RAP material stockpile passing the 5/8 inch sieve.

RAP shall be stockpiled so that segregation is minimized. When two RAP stockpiles are used, acceptable methods to prevent intermingling of stockpiles shall be provided.

The Engineer reserves the right to reject obviously defective salvaged material or salvaged material that is not representative of the material used in the mix design.

416-3.05 Warm Mix Asphalt Technologies:

Warm Mix Asphalt (WMA) technologies include plant water foaming processes, mineral additives, and chemical additives. WMA technologies shall be approved prior to their use in accordance with Materials Practice and Procedure Directive No. 23, "Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete".

416-4 Mix Design:

Utilizing mineral aggregate and RAP which has been crushed, processed, separated and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate and RAP samples used for mix design purposes shall be representative of materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design engineer shall meet the requirements given in ADOT Materials Practice and Procedure Directive No. 4, "Asphaltic Concrete Mix Design Proposals and Submittals". The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Practice and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

The contactor may propose the use of a mix design that has been developed for a previous project that is less than a year old with no additional requirements. The proposed mix design shall meet the requirements of these specifications. If the proposed mix design is greater than one year old but less than two years old, the contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing virgin mineral aggregate and RAP have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate and RAP proposed for use. The Engineer will determine if

the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of that project.

The mix design shall contain as a minimum:

(A) The name and address of the testing organization and the person responsible for the mix design testing;

(B) The specific location(s) of the source(s) of mineral aggregate;

(C) The supplier, refinery, type of asphalt cement, and any modifiers including polymers. The source and type of mineral admixture. The percentage of asphalt cement and mineral admixture to be used;

(D) The anticipated mineral aggregate gradation in each stockpile;

(E) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture;

(F) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, uncompacted void content (for Special Mix), percent carbonates (if required), immersion compression results (Index of Retained Strength, wet and dry strengths), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density; and

(G) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

When RAP is used in the mixture, the following additional information shall be included in the mix design:

(H) The specific location(s) of the source(s) of RAP;

(I) The anticipated RAP gradation, RAP aggregate gradation, and RAP binder content in each stockpile;

(J) If greater than 17 percent RAP binder is used in the mixture, the results of all tests on the recovered RAP binder, as well as all tests on the blend of virgin binder and recovered RAP binder;

(K) The percent RAP binder, virgin binder, and total binder in the mixture;

(L) The composite gradation of virgin and RAP aggregates, with and without mineral admixture. The composite gradation of the virgin aggregate and RAP, with and without mineral admixture;

(M) The results of all testing, determinations, etc., for the RAP, virgin aggregate, RAP aggregate, and composite of virgin and RAP aggregates as required, such as: specific gravity, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, uncompacted void content (for Special Mix), and percent carbonates; and

(N) The viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges for the blended binder, if greater than 17 percent RAP binder is used in the mixture, as well as the actual laboratory mixing and compaction temperatures used.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the additional mix design requirements specified in Materials Practice and Procedure Directive No. 23, “Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete”, shall also be included in the mix design.

Test results used in the formulation of the mix design shall be from testing performed no earlier than 45 days prior to the date the mix design is signed by the mix design engineer. Historical abrasion values may be supplied on sources provided the testing was conducted within the past two years.

The mix design shall be submitted to the Engineer under a cover letter signed by an authorized representative of the contractor.

A copy of the mix design and representative samples of the materials used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and for the determination of sand equivalent and fractured coarse aggregate particles. When Special Mix is used, the uncompacted void content shall also be determined. Approximately 300 pounds of virgin mineral aggregate (proportional to the mix design gradation), 3 gallons of asphalt cement, and 1 gallon of mineral

admixture shall be submitted. When RAP is used, a minimum of 40 pounds of representative RAP material and a minimum of 10 pounds of solvent-extracted RAP aggregate, per AASHTO T 164, Method A, shall be submitted. If RAP is fractionated, the RAP and RAP aggregate from each stockpile shall be kept separate. The Engineer shall witness the sampling of the virgin mineral aggregate and RAP. The mix design and samples shall be submitted to the Engineer at least five working days prior to the start of asphaltic concrete production.

The sand equivalent, fractured coarse aggregate particles, and (for Special Mix) uncompacted void content shall meet the requirements specified in Subsection 416-3.01 of the specifications. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information, for further action and resubmission by the contractor.

If the contractor elects to change its source(s) of mineral aggregate or RAP, or adds or deletes the use of a stockpile(s) regardless of source, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

If changes are made in the source or type of bituminous material, or the type of mineral admixture, the contractor shall provide verification testing results. Verification testing shall be performed at the original mix design asphalt content using the original mineral aggregate and RAP (if used), the proposed bituminous material, and/or the proposed mineral admixture. Three specimens shall be fabricated and tested for bulk density, maximum theoretical density, and effective voids. The percent effective voids shall be within $\pm$ 0.2 of the percent effective voids in the original design and also be within the current effective voids mix design specification limits. Verification testing results shall not replace target values shown in the original mix design. All target values from the original design shall be used in future production with the exception of any self-directed target value changes that are requested. The verification process does not ensure that the contractor can meet the target values during production.

In addition to the verification testing specified above, verification testing for immersion compression may also be required. If there is a change in the type of mineral admixture, immersion compression testing is required. If there is a change in the source or type of bituminous

material, immersion compression testing is required if the Index of Retained Strength of the original mix design is less than 10 percentage points greater than the specified minimum, or if the Wet Strength is less than 100 pounds per square inch greater than the specified minimum.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. Self-directed target changes shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size):	
3/8 inch	±4% from mix design target value
No. 8	±4% from mix design target value
No. 40	±2% from mix design target value
Asphalt Cement Content	Within range of +0.4% to -0.2% from mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

In no case shall the approval of mix design changes relieve the contractor of the responsibility for the results obtained by the use of such approved changes.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer or without preparing a new mix design.

416-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) of the specifications. At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed:

(A) Aggregate production, including crusher methods, pit extraction, and washing;

(B) RAP production, including milling, crushing, screening, and handling methods;

(C) Stockpile management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention;

(D) Proportioning and plant control, including plant scale calibration, mix temperature control, storing method, and addition of admixture;

(E) Transporting and placing, including hauling distance and temperature control, segregation and non-uniform placement control, and joint placement and technique; and

(F) Compaction, including types and weight of rollers, establishing and monitoring of roller patterns, and temperature controls.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
Type of Test	**Test Method**	**Sampling Point**	**Minimum Testing Frequency**
Virgin Mineral Aggregate			
Gradation	AASHTO T 27	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176	Crusher Belt or Stockpile	1 per 2,000 Tons of total virgin aggregate (1)
Fractured Coarse Aggregate Particles	AASHTO T 335		
Uncompacted Void Content (2)	AASHTO T 304 Method A		
Reclaimed Asphalt Pavement			
Gradation, Moisture Content, and Binder Content	AASHTO T 308	Crusher Belt or Stockpile	1 per stockpile per day
RAP Aggregate			
Gradation	AASHTO T 11, T 27	Crusher Belt or Stockpile	1 per stockpile per day
Fractured Coarse Aggregate Particles	AASHTO T 335		1 per stockpile every other day
Asphaltic Concrete			
Gradation	AASHTO T 27 or T 308 (for both Non-Rap and RAP mixes)	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1,000 Tons
Asphalt Content	AASHTO T 287, T 308 (for both Non-RAP and	Roadway or Plant	1 per 1,000 Tons

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
Type of Test	**Test Method**	**Sampling Point**	**Minimum Testing Frequency**
	RAP mixes), or other approved methods		
Voids	AASHTO R 68, T 166, T 209, T 245, T 269		1 per 1,000 Tons each day. Maximum of 4 per day.
Compaction	AASHTO T 355	Roadway	1 per 300 tons

Notes:

(1) Prior to the completion of the mix design, quality control tests on mineral aggregate shall be performed based on the anticipated percent use of each stockpile. Samples taken from individual stockpiles may be composited prior to performing the required tests, or testing may be performed on material from each stockpile and the composite test result for each required test determined mathematically.

(2) For Special Mix.

416-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading, and finishing of asphaltic concrete and for the applying of bituminous material, such as tack coats, prime coats, and provisional seals, all in accordance with the appropriate portions of the specifications.

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the specifications.

During production, the percent RAP aggregate and percent RAP binder shall not exceed the maximum allowed in Subsections 416-3.01(C), 416-3.03(C), and 416-3.04 of the specifications. In addition, the percent RAP material shall be maintained to within plus 2 percent and minus 5 percent of the mix design value(s). When two RAP stockpiles are used, this tolerance shall apply to the total percent RAP material in the mixture, as well as the percent RAP material from each stockpile.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 degrees F unless a higher temperature is recommended in writing by the asphalt binder supplier and approved by the Engineer.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which shall distribute the mixture uniformly in front of adjustable screeds.

Pavers shall be equipped with a screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors shall be wetted with water, or if necessary soapy water, or a release agent in order to prevent the sticking of asphaltic concrete. All other equipment surfaces shall be treated when necessary with a release agent. Only release agents evaluated through AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) are acceptable for use. The results from AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) testing, when tested in accordance with AASHTO T 383, shall conform to the requirements shown in the table below:

RELEASE AGENT TEST	REQUIREMENT
Asphalt Stripping Test Diluted Non-Diluted (Full Strength)	 No Stripping No Stripping
Asphalt Performance Test	Less than or equal to 10.0% after the third cycle

Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Longitudinal joints of each course shall be staggered a minimum of 1 foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on 10 foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately 1 foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within 1 foot of the center of a lane or within 1 foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using a material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by the Engineer.

A light coat of bituminous material shall be applied to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with AASHTO T 329.

When Warm Mix Asphalt (WMA) technologies are used, the contractor shall comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mixture. The contractor shall comply with the manufacturer's recommendations regarding transporting, storage, and delivery of additives and water foaming processes. The contractor shall maintain a copy of the manufacturer's recommendations on file at the asphalt mixing plant and make those recommendations available for reference while using WMA technologies.

416-7 Acceptance:

416-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

(A) Sand equivalent;
(B) Fractured coarse aggregate particles;
(C) Uncompacted void content (for Special Mix);
(D) Material spread;
(E) Gradation;
(F) Asphalt cement content;
(G) Effective voids;
(H) Stability;
(I) Compaction; and
(J) Smoothness

416-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate:

During asphaltic concrete production, the Engineer shall obtain and test samples of material for the determination of the sand equivalent and fractured coarse aggregate particles. When Special Mix is used, the uncompacted void content shall also be determined. When RAP is used in the mixture, the sand equivalent and uncompacted void content shall be determined on the composite of virgin aggregates only. Samples shall be obtained from the cold feed belt prior to the addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible.

When RAP is used in the mixture, the material for determining the fractured coarse aggregate particles shall come from an asphaltic concrete sample taken and tested in accordance with AASHTO T 308, as specified in Subsection 416-7.04(A) of the specifications. However, if the Engineer determines that excessive breakdown of the aggregate has occurred due to the use of the ignition furnace, the fractured coarse aggregate particles testing shall be performed on the combination of RAP aggregate, as obtained in accordance with AASHTO T 308, and virgin mineral aggregate.

Virgin mineral aggregate will be acceptable for sand equivalent if it meets the minimum requirements specified in Subsection 416-3.01 of the specifications.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 416-3.01 of the specifications.

For Special Mix, the uncompacted void content shall meet the minimum requirements specified in Subsection 416-3.01 of the specifications. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 416-4 of the specifications or correcting deficiencies in the aggregate stockpiles.

416-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(D) of the specifications.

The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, and tons placed in each lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the mix design bulk density unless a request is made by the contractor to use a production bulk density. If a request is made to use production bulk density, the first three non-rejected lots following the test lot will be used to determine the average production bulk density. All lots placed prior to establishing the average production bulk density shall be calculated using the mix design bulk density. For each new mix design used on the project, a new production bulk density may be requested by the contractor. In addition, if conditions warrant during asphalt

production, the contractor may request establishment of a new average production bulk density. All requests to use a production bulk density shall be made in writing and approved by the Engineer prior to use. The same procedure will be used for determining average production bulk density in all cases. Changes to the bulk density for calculating spread quantities will not be retroactive.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A lot will be considered to be acceptable, with a zero pay factor, if the actual quantity placed varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary from the required quantity by -2.1 to -12.0 percent, the appropriate pay factor will be determined in accordance with Table 416-1. This pay factor will be utilized in determining the pay adjustment as outlined in Subsection 416-9 of the specifications.

416-7.04 Gradation, Asphalt Cement Content, Effective Voids and Stability:

(A) General:

A mixture properties lot shall be considered to be one shift's production. In the event a shift's production is less than 1,200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix design or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples will be taken in accordance with the requirements of AASHTO R 97 Plate Method and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 75 pounds. The Engineer will split the sample and save one-half for 15 days after written notification to the contractor of test results for that lot has been made. The material will be tested by the Engineer for the following properties:

Test Property	Test Method
Asphalt Cement Content	AASHTO T 308 (for both Non-RAP and RAP mixes) (See Notes 1 and 2 below)
Gradation	
Marshall Density and Stability	AASHTO R 68, T 245
Maximum Theoretical Density	AASHTO T 209
Effective Voids	AASHTO T 269
Notes:	

(1) A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs.

(2) Ignition furnace results will be corrected for asphalt cement content in accordance with Subsection 416-7.04(B) as required.

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

A mixture-properties lot placed with an average stability below 2,500 pounds for base mixes, or 1,750 pounds for 1/2 inch or 3/4 inch mixes shall be rejected, and shall be subject to an engineering analysis of anticipated performance in accordance with Subsection 416-9(E) of the specifications. Production shall cease until the contractor proposes a corrective action the Engineer finds acceptable. If the Engineer rejects the proposed corrective action, the contractor shall submit a revised mix design.

The target values for gradation, asphalt cement content, and effective voids are given in the contractor's mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	**LL** (Note 1)	**UL** (Note 1)
Gradation (Sieve size):		
3/8 inch	TV - 8.0	TV + 8.0
No. 8	TV - 8.0	TV + 8.0
No. 40	TV - 5.0	TV + 5.0
No. 200	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 2.0

Notes:

(1) The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the applicable target value (TV).

The Engineer will determine the PT for each measured characteristic in accordance with Subsection 416-9(H) of the specifications, and utilizing Table 416-1 will determine the pay factor for each measured characteristic.

In the event the contractor elects to question the mixture property test results, the contractor may request referee testing in accordance with Subsection 416-9(I) of the specifications.

(B) Ignition Furnace Correction:

Ignition furnace testing results shall be corrected in accordance with ADOT Materials Practice and Procedure Directive No. 20, “Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete”.

416-7.05 Compaction:

(A) Courses 1-1/2 Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F and the ambient temperature at the beginning of placement is at least 65 degrees F and rising. The placement shall be stopped when the ambient temperature is 70 degrees F or less and falling.

When Warm Mix Asphalt (WMA) technologies are not used in the mixture, asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the recommended temperature range for compaction during production shall be shown on the mix design and shall be approved by the Engineer.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic-tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than 8 tons.

Pneumatic-tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. Pneumatic-tired compactors shall be constructed so that the total weight of the compactor will be

varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic-tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No.1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2-4*
Finish	Static Steel	Static Steel	1-3	1-3
Note: * Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure.

One pneumatic-tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of 1 inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

(B) Courses Greater than 1-1/2 Inches in Nominal Thickness:

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractor's responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

A compaction lot shall be identical to the mixture properties lot described in Subsection 416-7.04 of the specifications. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(D) of the specifications. Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. The Engineer will designate 10 random locations within the lot, and the contractor shall take two cores at each location; however, if more than one shift constitutes a lot, two cores shall be taken from a minimum of two random locations each shift, or as directed by the Engineer. The Engineer will save one core from each location for 15 days after written notification to the contractor of test results for the lot has been made. Randomly selected locations will be determined to the nearest 0.5 foot in the transverse direction and to the nearest foot in the longitudinal direction of the pavement course; however, the outside 1 foot of the unconfined pavement course will be excluded from testing as shown in Materials ADOT Practice and Procedure Directive (P.P.D.) No. 18, “Determining Sample Times and Locations for End Product Asphaltic Concrete”. Unless otherwise indicated in the project plans, shoulders shall be excluded from compaction lot testing on rehabilitation projects. Unless otherwise indicated in the project plans, placements without constant width including gore areas, tapers, and turn radii shall be excluded from compaction lot testing on all projects. P.P.D. No. 18 also addresses areas to be excluded relative to longitudinal joints. Areas excluded from testing will be compacted in accordance with Subsection 416-7.05(A) of the specifications. Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of AASHTO R 97. Cores shall be a minimum of 4 inches in diameter and shall be taken not later than two working days after placement of the asphaltic concrete. The cores shall be delivered to the Engineer immediately upon being taken. The bulk density of each core will be determined by the Engineer in accordance with the requirements of AASHTO T 166. The test results will be furnished to the contractor within four working days of receipt of cores by the Engineer. In areas where more than one lift is placed in the same lot, coring shall be accomplished through the full depth of the lifts after the final lift is placed, and the compaction density shall be based on the full depth of the lifts.

The target value for compaction shall be 5.5 percent in-place air voids. In-place air voids shall be determined in accordance with AASHTO T 269. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 416-7.04 of the specifications.

The Upper Limit (UL) is 8.0 percent in-place air voids and the Lower Limit (LL) is 3.0 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 416-9(H), and

utilizing Table 416-1 of the specifications will determine the compaction pay factor.

In the event the contractor elects to question the core test results, the contractor may request referee testing in accordance with Subsection 416-9(I) of the specifications.

416-7.06 Smoothness and Surface Tolerances:

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13 of the specifications.

Regardless of whether testing in accordance with Subsection 109.13 of the specifications is specified or not, the following requirements shall be met:

(A) The surface of any lift of asphaltic concrete placed under this section of the specifications, shall be tested and shall not vary by more than 1/4 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints; and

(B) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

416-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement, and mineral admixture. Measurement will include any quantity used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

No separate measurement or payment will be made for mineral admixture, the cost being considered as included in the cost of the asphaltic concrete.

416-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate pay factors as hereinafter provided.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, no separate payment will be made for WMA additives or technologies, necessary hot plant modifications, or other associated costs.

For the purpose of determining acceptability and appropriate pay factors, each unit of asphaltic concrete will be included in three separate lots: a "spread lot", a "mixture-properties lot", and a "compaction lot". The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor.

The contractor may request to place the first lot of each mix type as a test strip. Requests to place a test strip shall be made in writing and acknowledged by the Engineer prior to start of production. A test strip shall be limited to 1,000 tons and may only be placed on shoulders, ramps, cross roads, or other areas approved by the Engineer. A test strip shall be excluded from the mixture-properties lot pay factor and the compaction lot pay factor; however, all other provisions of Subsection 416-9 of the specifications shall still apply to such areas.

The Engineer may exclude asphaltic concrete from the spread lot and from the spread lot pay factor calculations if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

The Engineer may exclude certain locations from the mixture properties lot and/or the compaction lot and from the random sampling used in determining the mixture properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 416-7.03 of the specifications. If the quantity in a spread lot is found to vary by more than +5.0 percent from the required quantity, no payment will be made for the material which exceeds +5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than -12.0 percent from the required quantity, the spread lot will be rejected.

(B) Mixture-Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

(1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 416-7.04 of the specifications.

(2) A single pay factor shall be determined for Gradation and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content.

(3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed $3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 416-9(E) of the specifications shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be determined as set forth in Subsection 416-7.05(B) of the specifications.

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor for each project shall be determined as follows:

(1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 416-7.03 of the specifications.

(2) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 416-7.04 of the specifications, regardless of which project(s) the samples fall within.

(3) PT values and pay factors for compaction, for those areas subject to Subsection 416-7.05(B) of the specifications, shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that Subsection.

(4) The mixture-properties lot pay factor shall be determined separately for each project in accordance with Subsection 416-9(B) of the specifications, utilizing the individual pay factors determined in (2) above.

(5) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 416-9(C) of the specifications, utilizing the pay factor determined in (3) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within 25 days, or as agreed upon by the Engineer, after receiving notice that a spread lot, mixture-properties lot, or compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus $1.00 per ton for spread lots, minus $5.00 per ton for compaction lots, minus $3.00 per ton for mixture properties lots in reject for Gradation only, minus $5.00 per ton for mixture-properties lots in reject for Asphalt Cement Content and/or Effective Voids only, and minus $5.00 per ton for mixture-properties lots in reject for Asphalt Cement Content and/or Effective Voids and also Gradation. Positive mixture properties lot pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place. In addition, for any mixture-properties lot that is in reject due to Asphalt Cement Content but allowed to remain in place, payment shall not be made for asphalt cement quantities in excess of the upper limit (UL) as determined in Subsection 416-7.04(A) of the specifications.

The proposal shall contain an engineering analysis of the anticipated performance (i.e. reduction in serviceability, in years) of the asphaltic concrete if left in place. The engineering analysis shall also detail the potential root cause of the problem, any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall only include acceptance or referee test results, as applicable to the standards specifications. The engineering analysis shall include the expected additional cost to the Department (over original performance life) to maintain the pavement at an acceptable condition. The engineering analysis shall include supporting information such as pictures of the area, control charts, plant and field records, etc. The engineering analysis shall be performed by an independent professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected mixture properties lot or a rejected compaction lot is submitted for referee testing by the contractor, the 25 days allowed to prepare an engineering analysis will begin upon notification of referee test results.

The contractor may submit a written proposal without an engineering analysis for Engineer's evaluation and approval, that a mixture properties lot with a PT value lower than 50 on gradation and/or asphalt

cement content be allowed to remain in place if the application of a Self-Directed Target Change as outlined in Subsection 416-4 of the specifications would bring the PT value to 50 or greater. This written request shall also include the proposed revised PT calculations. Upon Engineer's verification and approval of the request, the material shall remain in place at the maximum negative pay factor(s) specified in this subsection for the mixture properties lot in reject.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factor(s), and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

(1) The occurrence of two or more rejected lots within any 10 consecutive production lots.

(2) The occurrence of three consecutive negative mixture properties lot pay factors or three consecutive negative compaction lot pay factors.

(3) The occurrence of five or more pay factors that are negative either for a mixture properties lot or for a compaction lot within any 10 consecutive production lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 416-4 of the specifications, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design, or the course of action proposed in the engineering analysis, shall be implemented, and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

No separate measurement or payment will be made for asphalt cement (bituminous material), the cost being considered as included in the cost of the asphaltic concrete.

A reduction in payment to the contractor for asphaltic concrete will be made for quantities of asphalt cement (bituminous material) that do not

meet the requirements of Section 1005 as determined by corresponding test results. Adjustments in payment shall be made in accordance with the requirements of Section 1005 of the specifications.

(G) Smoothness:

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13 of the specifications.

(H) Statistical Acceptance:

The "Total Percentage of Lot within UL and LL (PT)" shall be determined in accordance with Subsection 109.11 of the specifications.

Pay Factors (PF) shall be determined by entering Table 416-1 with PT.

TABLE 416-1
PAY FACTORS

Material Spread		Mixture Properties and Compaction			
			Pay Factors (Dollars per Ton)		
Negative Variance %	Pay Factor (Dollars per Ton)	PT	Gradation and Asphalt Cement Content	Effective Voids	Compaction
2.1 - 3.0	- 0.10	100	0.00	+ 2.00	+ 2.00
3.1 - 4.0	- 0.20	95 - 99	0.00	+ 1.00	+ 1.00
4.1 - 5.0	- 0.30	90 - 94	0.00	0.00	0.00
5.1 - 6.0	- 0.40	85 - 89	0.00	- 0.25	- 0.25
6.1 - 7.0	- 0.50	80 - 84	- 0.25	- 0.50	- 0.50
7.1 - 8.0	- 0.60	75 - 79	- 0.50	- 0.75	- 0.75
8.1 - 9.0	- 0.70	70 - 74	- 0.75	- 1.00	- 1.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25	- 1.25
10.1 - 11.0	- 0.90	60 - 64	- 1.50	- 1.50	- 1.75
11.1 - 12.0	- 1.00	55 - 59	- 2.00	- 2.00	- 2.25
More than 12.0	Reject	50 - 54	- 2.50	- 2.50	- 3.00
See Subsections 416-9(A) and (E)		Less than 50	Reject-See Subsection 416-9(E)		

(I) Referee Testing:

(1) Referee Testing Performed for Mixture Properties Only:

Within 15 days after written notification to the contractor of test results for a particular mixture properties lot, the contractor may make a written request for referee testing. The referee testing shall be performed by an independent approved laboratory designated by the Department. The testing of the samples will be performed by the independent testing

laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the test results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for the following properties:

Test Property	Test Method
Asphalt Cement Content	AASHTO T 308 (for both Non-RAP and RAP mixes)
Gradation	
Marshall Density and Stability	AASHTO R 68, T 245
Maximum Theoretical Density	AASHTO T 209
Effective Voids	AASHTO T 269

The results of the referee testing will be binding on both the contractor and the Department.

Using the referee testing results, the Engineer will determine new PT's for all characteristics.

When referee testing is performed on a mixture properties lot, the referee test result for the average maximum theoretical density will be used to determine a new PT for compaction.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (mixture properties plus compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties of that particular lot.

(2) Referee Testing Performed for Compaction Only:

Within 15 days after written notification to the contractor of test results for a particular compaction lot, the contractor may make a written request for referee testing. The bulk density of each of the cores previously saved will be determined in accordance with the requirements of AASHTO T 166 by an independent testing laboratory designated by the Department. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, or the test results by the Department. The percent air voids will be determined in accordance with AASHTO T 269. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 416-7.04 of the specifications.

The results of the referee testing will be binding on both the contractor and the Department.

When referee testing is performed on the compaction lot, the Engineer will determine a new PT for compaction using the referee testing results.

The Department will pay for the referee testing; however, if the pay factor of the compaction lot does not improve or is reduced, or the compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete will be reduced by the amount of the cost of referee testing for the compaction of that particular lot.

(3) Referee Testing Performed for Both Mixture Properties and Compaction:

When referee testing is performed, as described above, for both the mixture properties lot and the compaction lot, the Engineer will use the referee test results to determine new PT's as specified in Subsections 416-9(I)(1) and 416-9(I)(2) of the specifications.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (mixture properties plus compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties and compaction of that particular lot.

SECTION 417 ASPHALTIC CONCRETE (END PRODUCT) SHRP VOLUMETRIC MIX:

417-1 Description:

The work under this section shall consist of constructing Asphaltic Concrete (End Product) SHRP Volumetric Mix, hereinafter asphaltic concrete, by furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt cement) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of the specifications.

Reclaimed asphalt pavement (RAP), as defined in Subsection 417-3.04 of the specifications, may be used in the mixture provided all requirements of the specifications are met. References to the use of RAP in this section apply only if RAP is utilized as part of the mixture. ADOT Materials Practice and Procedure Directive No. 20, "Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete", shall be used in conjunction with the requirements of the specifications.

Warm Mix Asphalt (WMA) technologies may be used in the mixture at the option of the contractor provided all requirements of the specifications are met. WMA is defined as asphaltic concrete that is produced within the temperature range of 215 to 275 degrees F. WMA

can be produced by one or a combination of several WMA technologies including plant water foaming processes, mineral additives, and chemical additives. The requirements for incorporating WMA technologies in the mixture are given in these specifications and in Materials Practice and Procedure Directive No. 23, “Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete”.

The contractor shall acquire and make all arrangements for a source or sources of material, furnish a mix design which will meet the design criteria specified hereinafter, and provide all the equipment, materials, and labor necessary to complete the work.

The type of asphaltic concrete mix will be specified in the Special Provisions.

417-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed utilizing a minimum ratio of three (3) for the lift thickness to nominal maximum aggregate size. Mix designs shall be developed by the contractor. Each mix design shall meet the criteria in Table 417-1 and the grading requirements in Table 417-2 when tested in accordance with Arizona Test Method 815 for mixes without RAP and Arizona Test Method 833 for mixes with RAP, with the noted exceptions.

TABLE 417-1
ASPHALTIC CONCRETE MIX DESIGN CRITERIA

Criteria	Requirements	
	1/2” Mix	3/4” Mix
Voids in Mineral Aggregate: %, Range	14.5-16.5	13.5-15.5
Effective Voids: %, Range	4.0 ± 0.2	
Absorbed Asphalt: %, Range	0 - 1.0	
Index of Retained Strength: % (Arizona Test Method 802) (See Note 6)	60 Minimum (See Note 7 below)	
Wet Strength: psi (Arizona Test Method 802) (See Note 6)	150 Minimum	

TABLE 417-1
ASPHALTIC CONCRETE MIX DESIGN CRITERIA

Notes:

(1) Mix design laboratory compacted test specimens, except for Arizona Test Method 802, shall be prepared using a gyratory compactor in accordance with AASHTO T 312, except compaction shall be performed to the number of gyrations specified for N-max in Note 4 below and the density of the compacted specimens shall be calculated for N-design gyrations.

(2) The mix design shall be formulated in a manner described for Level 1 mix designs in The Superpave Mix Design Manual for New Construction and Overlays (SHRP-A-407) except that volumetrics will be determined in accordance with Arizona Test Method 815, or Arizona Test Method 833 if RAP is used, and the number of trial blend gradations necessary will be determined by the mix design laboratory. Duplicate gyratory samples shall be prepared at a minimum of 3 binder contents to select the recommended binder content. The completed mix design shall meet all the mineral aggregate and mix design criteria specified herein. In addition, when RAP is used in the mixture, SHRP-A-407 shall be modified as necessary to incorporate the RAP provisions and requirements of Arizona Test Method 833.

(3) The ratio of the mix design composite gradation target for the No. 200 sieve, including mineral admixture, to the effective asphalt content shall be as specified in the Special Provisions.

(4) For purposes of design, the number of gyrations (N-design) shall be as specified in the Special Provisions. The calculated density of the specimens shall be less than 89.0 percent of maximum theoretical density at the number of gyrations (N-initial) specified in the Special Provisions. The density of the specimens shall be less than 98.0 percent of the maximum theoretical density at the number of gyrations (N-max) specified in the Special Provisions.

(5) Oven aging period for mix design gyratory samples shall be two hours.

(6) For mixes without RAP, Arizona Test Method 802 (as modified by Arizona Test Method 815). For mixes with RAP, Arizona Test Method 802 (as modified by Arizona Test Method 833).

(7) If the average elevation of the project is above 3,500 feet, the Index of Retained Strength shall be a minimum of 70 percent.

TABLE 417-2

MIX DESIGN GRADING LIMITS FOR 3/4 INCH MIX

Sieve Size	Coarse Band		Fine Band	
	Percent Passing			
	Without Admixture	With Admixture	Without Admixture	With Admixture
1 inch	100	100	100	100
3/4 inch	90 - 100	90 - 100	90 - 100	90 - 100
1/2 inch	43 - 89	44 - 89	60 - 89	60 - 89
No. 8	23 - 35	24 - 36	36 - 49	37 - 50
No. 40	2 - 17	3 - 18	15 - 49	16 - 50
No. 200	2.0 - 5.0	3.0 - 6.5	2.0 - 5.0	3.0 - 6.5

MIX DESIGN GRADING LIMITS FOR 1/2 INCH MIX

Sieve Size	Coarse Band		Fine Band	
	Percent Passing			
	Without Admixture	With Admixture	Without Admixture	With Admixture
3/4 inch	100	100	100	100
1/2 inch	90 - 100	90 - 100	90 - 100	90 - 100
3/8 inch	53 - 89	53 - 89	64 - 89	64 - 89
No. 8	28 - 39	29 - 40	40 - 52	41 - 53
No. 40	2 - 19	3 - 20	17 - 52	18 - 53
No. 200	2.0 - 5.5	3.0 - 7.0	2.0 - 5.2	3.0 - 7.0

Notes:

(1) The contractor may provide a mix meeting the Fine Band or Coarse Band mix design grading limits unless otherwise specified.

(2) In addition to the mineral aggregate grading requirements, the contractor's mix design shall provide a minimum of 25 percent intermediate size mineral aggregate for the 1/2-inch mix and 20 percent for the 3/4-inch mix. Intermediate size mineral aggregate is defined as the percentage of mineral aggregate passing the 3/8-inch sieve and retained on the No. 8 sieve in the combined mineral aggregate, exclusive of mineral admixture.

417-3 Materials:

For comparative purposes, quantities shown in the bidding schedule have been calculated as shown in the Special Provisions.

417-3.01 Mineral Aggregate:

(A) General:

Mineral aggregate shall consist of virgin aggregate, or a combination of virgin aggregate and aggregate from RAP (RAP aggregate). When the

terms “mineral aggregate” or “aggregate” are used without being further described as “virgin” or “RAP”, the intended meaning is the total aggregate material used in the mixture.

No individual stockpile or hot bin usage of either virgin aggregate or RAP aggregate shall be less than 3 percent of the total mineral aggregate.

(B) Virgin Mineral Aggregate:

The contractor shall provide a source in accordance with the requirements of Section 1001 of the specifications.

Coarse virgin mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine virgin mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as virgin mineral aggregate, so all crushing operations can be inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer’s satisfaction that the virgin mineral aggregate has been crushed. Any material inspected by the Department as crushed material shall be separated from the contractor’s other stockpiles and reserved for use throughout the project duration.

For mixes which not contain RAP, the contractor may blend uncrushed fine virgin aggregate up to a maximum of 15 percent of the total aggregate for mixes meeting the fine band grading requirements or up to a maximum of 10 percent of the total aggregate for mixes meeting the coarse band grading requirements. For mixes which contain RAP, the contractor may blend uncrushed fine virgin aggregate up to a maximum of 10 percent of the total aggregate. The total composite of virgin fine aggregate shall meet the requirement for uncompacted void content. The uncrushed fine virgin aggregate shall be 100 percent passing the 1/4-inch sieve and contain not more than 4.0 percent passing the No. 200 sieve. Should the contractor modify the method of producing either the uncrushed or crushed fine aggregate, the Engineer shall be immediately notified and the materials sampled and tested for determination of uncompacted void content.

(C) RAP Mineral Aggregate:

RAP aggregate shall conform with Materials Practice and Procedure Directive No. 20, "Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete".

(D) Mineral Aggregate Characteristics:

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods:

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity (1)	Arizona Test Method 251	2.350 - 2.850
Combined Water Absorption (1)	Arizona Test Method 251	0 - 3.0%
Sand Equivalent (1)	AASHTO T 176 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 4 material is required.)	Minimum 55
Abrasion (2)	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%
Fractured Coarse Aggregate Particles (3)	AASHTO T 335	Minimum 85% with at least two fractured faces and minimum 92% with at least one fractured face (plus No. 4 material)
Flat and Elongated Particles (3)	ASTM D4791 (except test shall be performed on plus No. 4 material)	Maximum 10% (of the plus No. 4 material) 5:1
Uncompacted Void Content (1)	AASHTO T 304 Method A	Minimum 45.0%
Carbonates (3) and (4)	Arizona Test Method 238	Maximum 20%
Notes:		

(1) When the mix design contains RAP, the requirements shall be for the virgin aggregate portion only.

(2) Abrasion shall be performed separately on materials from each source of mineral aggregate, including RAP aggregate. All sources shall meet the requirements for abrasion.

(3) When the mix design contains RAP, the requirements shall be for the composite of virgin and RAP aggregate.

(4) Testing for carbonates only applies if either of the following conditions exist:

(a) The asphaltic concrete is the designed final pavement surface normally used by traffic; and/or

(b) The asphaltic concrete, temporary or otherwise, will be subject to traffic for more than 60 days.

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. When RAP is used in the mixture, RAP aggregates for testing shall be obtained from the RAP material using Method A of AASHTO T 164, prior to combining with the virgin aggregate.

417-3.02 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate, unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for Wet Strength and Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either Portland cement, blended hydraulic cement, or hydrated lime conforming to the following requirements:

Material	Requirement
Portland Cement, Type I, or Type II	ASTM C150
Blended Hydraulic Cement, Type IP or IL	ASTM C595
Hydrated Lime	ASTM C1097

The certification and acceptance of Portland cement, blended hydraulic cement, and hydrated lime shall be in accordance with ADOT Materials Practice and Procedure Directive No. 13, "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, Silica Fume, and Lime".

417-3.03 Bituminous Material:

(A) General:

Bituminous material shall consist of performance grade (PG) asphalt binder (virgin binder), or a combination of virgin binder and binder from RAP (RAP binder). When the terms “bituminous material”, “asphalt cement”, “asphalt binder” or “binder” are used without being further described as “virgin” or “RAP”, the intended meaning is the total bituminous material used in the mixture.

The percent of asphalt cement used shall be based on the weight of total mix (asphalt cement, mineral aggregate, and mineral admixture).

(B) Virgin Bituminous Material:

Virgin asphalt cement shall be a performance grade (PG) asphalt binder, conforming to the requirements of Section 1005. The type of virgin asphalt binder shall be as specified in the Special Provisions. If RAP is used in the mixture, the virgin asphalt binder shall be as required to meet the blending requirements in Subsection 417-3.03(C) of the specifications and Arizona Test Method 833.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.17 ± 0.02 Pascal·seconds, measured in accordance with AASHTO T 316. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged virgin asphalt binder has a rotational viscosity of 0.28 ± 0.03 Pascal·seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 degrees F and 350 degrees F, and a viscosity-temperature curve developed in accordance with ASTM D2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 degrees F or a maximum laboratory compaction temperature exceeding 300 degrees F, the laboratory mixing and compaction temperature ranges shall be specified in writing by the virgin asphalt binder supplier. A viscosity-temperature curve will meet this requirement for written documentation if the viscosity-temperature curve is developed and submitted by the binder supplier and includes language that the recommended laboratory mixing and compaction temperatures are within acceptable ranges, and the submittal includes a statement indicating the maximum laboratory mixing temperature to which the binder can be heated without damage. The laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used, shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report. The laboratory mixing and compaction temperatures are for mix design purposes only. Field mixing and compaction temperatures are specified in Subsections 417-6 and 417-7 of the specifications.

(C) RAP Bituminous Material:

RAP binder content shall be determined by AASHTO T 308. RAP binder shall consist of the asphalt binder portion of the reclaimed asphaltic pavement. A maximum of 30 percent RAP binder, by weight of total binder in the mix, may be used in mixes placed in a lower lift (minimum 2 inches below finished surface). A maximum of 24 percent RAP binder, by weight of total binder in the mix, may be used at all other locations.

When less than or equal to 17 percent RAP binder is used, by weight of total binder in the mix, no testing is required on the RAP binder. When greater than 17 percent RAP binder is used, by weight of total binder in the mix, the RAP binder shall be extracted, recovered, and tested in accordance with the requirements of Arizona Test Method 833. The virgin binder grade shall be modified if necessary, to ensure the blend of virgin and RAP binder meets the PG grade specified in the Subsection 417-3.03(B) of the specifications. However, a change of only one virgin PG binder grade (6 degrees C on either or both the high and low temperatures) will be allowed from that shown in Subsection 417-3.03(B) of the specifications.

417-3.04 Reclaimed Asphalt Pavement (RAP):

RAP shall consist of salvaged, milled, pulverized, broken, or crushed asphalt pavement. If RAP is generated by milling, the minimum removal depth shall be 1-1/2 inches. The source of RAP may be from ADOT or other projects. The contractor shall be responsible for determining the suitability of the RAP for use in the mixture, regardless of its source.

RAP material shall pass the 1-1/4 inch sieve. For asphaltic concrete containing greater than 17 percent RAP binder, as determined by Ignition Furnace AASHTO T308, the RAP material shall be processed by one of the following: RAP material shall pass the 1-1/4 inch sieve and be fractionated into uniform coarse and fine stockpiles such that there will be a minimum amount of fines or formation of a single uniform RAP material stockpile passing the 5/8 inch sieve.

RAP shall be stockpiled so that segregation is minimized. When two RAP stockpiles are used, acceptable methods to prevent intermingling of stockpiles shall be provided.

The Engineer reserves the right to reject obviously defective salvaged material or salvaged material that is not representative of the material used in the mix design.

417-3.05 Warm Mix Asphalt Technologies:

Warm Mix Asphalt (WMA) technologies include plant water foaming processes, mineral additives, and chemical additives. WMA technologies shall be approved prior to their use in accordance with Materials Practice and Procedure Directive No. 23, “Requirements for

the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete".

417-4 Mix Design:

Utilizing mineral aggregate and RAP which has been crushed, processed, separated, and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate and RAP samples used for mix design purposes shall be representative of materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared by or under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design engineer shall meet the requirements given in ADOT Materials Practice and Procedure Directive No. 4, "Asphaltic Concrete Mix Design Proposals and Submittals". The mix design shall be provided in a format that clearly indicates all the mix design requirements and shall be sealed, signed, and dated by the mix design engineer.

The mix design shall be prepared by a mix design laboratory that has met the requirements of ADOT Materials Practice and Procedure Directive No. 19, "ADOT System for the Evaluation of Testing Laboratories".

The contactor may propose the use of a mix design that has been developed for a previous project that is less than a year old with no additional requirements. The proposed mix design shall meet the requirements of these specifications. If the proposed mix design is greater than one year old but less than two years old, the contractor shall provide evidence that the type and source of bituminous material, the type of mineral admixture, and the source and methods of producing virgin mineral aggregate and RAP have not changed since the formulation of the previous mix design. The contractor shall also provide current test results for all specified characteristics of the mineral aggregate and RAP proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use and if the previous use of the mix design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed mix design. Should the Engineer disapprove the use of the previously used mix design, the contractor shall prepare and submit a new mix design proposal in accordance with the requirements of these specifications.

A previously used mix design older than two years from the date it was formulated, sealed, signed, and dated shall not be allowed for use. Once approved for use on a project, a mix design may be used for the duration of that project.

The mix design shall contain as a minimum:

(A) The name and address of the testing organization and the person responsible for the mix design testing;

(B) The specific location(s) of the source(s) of mineral aggregate;

(C) The supplier, refinery, type of asphalt cement, and any modifiers including polymers. The source and type of mineral admixture. The percentage of asphalt cement and mineral admixture to be used;

(D) The anticipated mineral aggregate gradation in each stockpile;

(E) Mix design gradation and mix test results from all trial gradations. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture;

(F) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, flat and elongated particles, uncompacted void content, percent carbonates (if required), immersion compression results (Index of Retained Strength, wet and dry strengths), asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density; and

(G) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

When RAP is used in the mixture, the following additional information shall be included in the mix design:

(H) The specific location(s) of the source(s) of RAP;

(I) The anticipated RAP gradation, RAP aggregate gradation, and RAP binder content in each stockpile;

(J) If greater than 17 percent RAP binder is used in the mixture, the results of all tests on the recovered RAP binder, as well as all tests on the blend of virgin binder and recovered RAP binder;

(K) The percent RAP binder, virgin binder, and total binder in the mixture;

(L) The composite gradation of virgin and RAP aggregates, with and without mineral admixture. The composite gradation of the virgin aggregate and RAP, with and without mineral admixture;

(M) The results of all testing, determinations, etc., for the RAP, virgin aggregate, RAP aggregate, and composite of virgin and RAP aggregates as required, such as: specific gravity, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, flat and elongated particles, uncompacted void content, and percent carbonates; and

(N) The viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges for the blended binder, if greater than 17 percent RAP binder is used in the mixture, as well as the actual laboratory mixing and compaction temperatures used.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the additional mix design requirements specified in Materials Practice and Procedure Directive No. 23, “Requirements for the Use of Warm Mix Asphalt (WMA) Technologies in Asphaltic Concrete”, shall also be included in the mix design.

Test results used in the formulation of the mix design shall be from testing performed no earlier than 45 days prior to the date the mix design is signed by the mix design engineer. Historical abrasion values may be supplied on sources provided the testing was conducted within the past two years.

The mix design shall be submitted to the Engineer under a cover letter signed by an authorized representative of the contractor.

A copy of the mix design and representative samples of the materials used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and for the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content. Approximately 300 pounds of virgin mineral aggregate (proportional to the mix design gradation), 3 gallons of asphalt cement, and 1 gallon of mineral admixture shall be submitted. When RAP is used, a minimum of 40 pounds of representative RAP material and a minimum of 10 pounds of solvent-extracted RAP aggregate, per AASHTO T 164, Method A, shall be submitted. If RAP is fractionated, the RAP and RAP aggregate from each stockpile shall be kept separate. The Engineer shall witness the sampling of the virgin mineral aggregate and RAP. The mix design and samples shall be submitted to the Engineer at least five working days prior to the start of asphaltic concrete production.

The sand equivalent, fractured coarse aggregate particles, and uncompacted void content shall meet the requirements specified in Subsection 417-3.01 of the specifications. Additional testing of the

uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet the requirements specified herein, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information for further action and resubmission by the contractor.

If the contractor elects to change its source(s) of mineral aggregate or RAP, or adds or deletes the use of a stockpile(s) regardless of source, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

If changes are made in the source or type of bituminous material, or the type of mineral admixture, the contractor shall provide verification testing results. Verification testing shall be performed at the original mix design asphalt content using the original mineral aggregate and RAP (if used), the proposed bituminous material, and/or the proposed mineral admixture. Three specimens shall be fabricated and tested for bulk density, maximum theoretical density, and effective voids. The percent effective voids shall be within ± 0.2 of the percent effective voids in the original design and also be within the current effective voids mix design specification limits. Verification testing results shall not replace target values shown in the original mix design. All target values from the original design shall be used in future production with the exception of any self-directed target value changes that are requested. The verification process does not ensure that the contractor can meet the target values during production.

In addition to the verification testing specified above, verification testing for immersion compression may also be required. If there is a change in the type of mineral admixture, immersion compression testing is required. If there is a change in the source or type of bituminous material, immersion compression testing is required if the Index of Retained Strength of the original mix design is less than 10 percentage points greater than the specified minimum, or if the wet strength is less than 100 pounds per square inch greater than the specified minimum.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. Self-directed target changes shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size):	
3/8 Inch	±4% from the mix design target value
No. 8	±4% from the mix design target value
No. 40	±2% from the mix design target value
No. 200	None
Asphalt Cement Content	Within range of +0.4% to -0.2% from the mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

In no case shall the approval of mix design changes relieve the contractor of the responsibility for the results obtained by the use of such approved changes.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer or without preparing a new mix design.

417-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) of the specifications. At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed:

(A) Aggregate production, including crusher methods, pit extraction, and washing;

(B) RAP production, including milling, crushing, screening, and handling methods;

(C) Stockpile management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention;

(D) Proportioning and plant control, including plant scale calibration, mix temperature control, storing method, and addition of admixture;

(E) Transporting and placing, including hauling distance and temperature control, segregation and non-uniform placement control, and joint placement and technique; and

(F) Compaction, including types and weight of rollers, establishing and monitoring of roller patterns, and temperature controls.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	**TEST METHOD**	**SAMPLING POINT**	**MINIMUM TESTING FREQUENCY**
Virgin Mineral Aggregate			
Gradation	AASHTO T 11, T 27	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176		1 per 2,000 tons of total aggregate (1)
Fractured Coarse Aggregate Particles	AASHTO T 335		
Uncompacted Void Content	AASHTO T 304 Method A		
Reclaimed Asphalt Pavement			
Gradation, Moisture Content, and Binder Content	AASHTO T 308	Crusher Belt or Stockpile	1 per stockpile per day
RAP Aggregate			
Gradation	AASHTO T 11, T 27	Crusher Belt or Stockpile	1 per stockpile per day
Fractured Coarse Aggregate Particles	AASHTO T 335		1 per stockpile per every other day
Asphaltic Concrete			
Gradation	AASHTO T 11, T 27 or T 308 (for both Non-RAP and RAP mixes)	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1,000 tons
Asphalt Content	AASTHO T 287, T 308 (for both Non-RAP and RAP mixes), or other approved methods	Roadway or Plant	1 per 1,000 tons

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	**TEST METHOD**	**SAMPLING POINT**	**MINIMUM TESTING FREQUENCY**
Voids	AASHTO T 312 (2), T 166, T 209, T 269	Roadway or Plant	1 per 1,000 tons each day. Maximum of 4 per day.
Compaction	AASHTO T 355	Roadway	1 per 300 tons

Notes:

(1) Prior to the completion of the mix design, quality control tests on mineral aggregate shall be performed based on the anticipated percent use of each stockpile. Samples taken from individual stockpiles may be composited prior to performing the required tests, or testing may be performed on material from each stockpile and the composite test result for each required test determined mathematically.

(2) Except compaction shall be performed to the number of gyrations specified for N-max in Note 4 of Table 417-1 and the density of the compacted specimens shall be calculated for N-design gyrations.

417-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading, and finishing of asphaltic concrete, and for the applying of bituminous material, such as tack coats, prime coats, and provisional seals, all in accordance with the appropriate portions of the specifications.

The asphaltic concrete hot plant shall conform to the requirements of Section 403 of the specifications.

During production, the percent RAP aggregate and percent RAP binder shall not exceed the maximum allowed in Subsections 417-3.01(C), 417-3.03(C), and 417-3.04 of the specifications. In addition, the percent RAP material shall be maintained to within plus 2 percent and minus 5 percent of the mix design value(s). When two RAP stockpiles are used, this tolerance shall apply to the total percent RAP material in the mixture, as well as the percent RAP material from each stockpile.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 degrees F unless a higher temperature is recommended in writing by the asphalt binder supplier and approved by the Engineer.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at

certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Self-propelled paving machines shall spread the mixture within the specified tolerances, without segregation or tearing, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which shall distribute the mixture uniformly in front of adjustable screeds.

Pavers shall be equipped with a screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors shall be wetted with water, or if necessary soapy water, or a release agent in order to prevent the sticking of asphaltic concrete. All other equipment surfaces shall be treated when necessary with a release agent. Only release agents evaluated through AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) are acceptable for use. The results from AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) testing, when tested in accordance with AASHTO T 383, shall conform to the requirements shown in the table below:

RELEASE AGENT TEST	REQUIREMENT
Asphalt Stripping Test Diluted Non-Diluted (Full Strength)	 No Stripping No Stripping
Asphalt Performance Test	Less than or equal to 10.0% after the third cycle

Release agents which degrade, dissolve, or in any way damage the bituminous material shall not be used. Diesel fuel shall not be used as a release agent.

Longitudinal joints of each course shall be staggered a minimum of 1 foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on 10 foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately 1 foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within 1 foot of the center of a lane or within 1 foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using a material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the type of bituminous material used shall be acceptable to the Engineer. The amount of bituminous material used shall be as directed by the Engineer.

A light coat of bituminous material shall be applied to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with AASHTO T 329.

When Warm Mix Asphalt (WMA) technologies are used, the contractor shall comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mixture. The contractor shall comply with the manufacturer's recommendations regarding transporting, storage, and delivery of additives and water foaming processes. The contractor shall maintain a copy of the manufacturer's recommendations on file at the asphalt mixing plant and make those recommendations available for reference while using WMA technologies.

417-7 Acceptance:

417-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

(A) Sand equivalent;
(B) Fractured coarse aggregate particles;
(C) Uncompacted void content;
(D) Material spread;
(E) Gradation;
(F) Asphalt cement content;
(G) Effective voids;
(H) Compaction; and
(I) Smoothness

417-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate:

During asphaltic concrete production, the Engineer shall obtain and test samples of material for the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content. When RAP is used in the mixture, the sand equivalent and uncompacted void content shall be determined on the composite of virgin aggregates only. Samples shall be obtained from the cold feed belt prior to the addition of mineral admixture, or from the stockpiles when sampling from the cold feed belt is not possible.

When RAP is used in the mixture, the material for determining the fractured coarse aggregate particles shall come from an asphaltic concrete sample taken and tested in accordance with AASHTO T 308, as

specified in Subsection 417-7.04(A) of the specifications. However, if the Engineer determines that excessive breakdown of the aggregate has occurred due to the use of the ignition furnace, the fractured coarse aggregate particles testing shall be performed on the combination of RAP aggregate, as obtained in accordance with AASHTO T 308, and virgin mineral aggregate.

Virgin mineral aggregate will be acceptable for sand equivalent if it meets the minimum requirements specified in Subsection 417-3.01 of the specifications.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 417-3.01 of the specifications.

The uncompacted void content shall meet the minimum requirements specified in Subsection 417-3.01 of the specifications. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified.

If the mineral aggregate fails to meet these requirements, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 417-4 of the specifications or correcting deficiencies in the aggregate stockpiles.

417-7.03 Material Spread:

A spread lot shall be considered to be one half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 417-9(D) of the specifications.

The contractor shall record information pertaining to each spread lot on forms provided by the Engineer. Information shall include the project number, date and period of time that each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness, and tons placed in each lot. Completed spread lot forms shall be signed by the contractor and given to the Engineer at the end of each shift.

The Engineer will calculate the quantity required in each spread lot using the mix design bulk density unless a request is made by the contractor to use a production bulk density. If a request is made to use production bulk density, the first three non-rejected lots following the test lot will be used to determine the average production bulk density. All lots placed prior to establishing the average production bulk density shall be calculated using the mix design bulk density. For each new mix design used on the project, a new production bulk density may be requested by the contractor. In addition, if conditions warrant during asphalt production, the contractor may request establishment of a new average production bulk density. All requests to use a production bulk density shall be made in writing and approved by the Engineer prior to use. The

same procedure will be used for determining average production bulk density in all cases. Changes to the bulk density for calculating spread quantities will not be retroactive.

The calculated quantity required in each spread lot will be compared to the actual quantity placed. A lot will be considered to be acceptable, with a zero pay factor, if the actual quantity placed varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary from the required quantity by -2.1 to -12.0 percent, the appropriate pay factor will be determined in accordance with Table 417-3. This pay factor will be utilized in determining the pay adjustment as outlined in Subsection 417-9 of the specifications.

417-7.04 Gradation, Asphalt Cement Content, and Effective Voids:

(A) General:

A mixture properties lot shall be considered to be one shift's production. In the event a shift's production is less than 1,200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix design or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples will be taken in accordance with the requirements of AASHTO R 97 Plate Method and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 130 pounds. The Engineer will split the sample and save one-half for 15 days after written notification to the contractor of test results for that lot has been made. The material will be tested by the Engineer for the following properties:

Test Property	Test Method
Asphalt Cement Content	AASHTO T 308 (for both Non-RAP and RAP mixes) (See Notes 1 and 2 below)
Gradation	
Gyratory Density	AASHTO T 312 (See Note 3 below)
Maximum Theoretical Density	AASHTO T 209
Effective Voids	AASHTO T 269

Notes:

(1) A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs.

(2) Ignition furnace results will be corrected for Asphalt Cement Content in accordance with Subsection 417-7.04(B) of the specifications as required.

(3) Except compaction shall be performed to the number of gyrations specified for N-max in Note 4 of Table 417-1 and the density of the compacted specimens shall be calculated for N-design gyrations.

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

The target values for Gradation, Asphalt Cement Content, and Effective Voids are given in the contractor's mix design. The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	**Coarse Band 3/4" and 1/2" Mixes**		**Fine Band 3/4" and 1/2" Mixes**	
	LL	**UL**	**LL**	**UL**
Gradation:				
3/8" sieve	TV - 8.0	TV + 8.0	TV - 6.0	TV + 6.0
No. 8 sieve	TV - 5.0	TV + 5.0	TV - 6.0	TV + 6.0
No. 40 sieve	TV - 5.0	TV + 5.0	TV - 5.0	TV + 5.0
No. 200 sieve	TV - 2.0	TV + 2.0	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5	TV - 2.0	TV + 1.5

Note:

(1) The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the center of the applicable Target Valve (TV).

The Engineer will determine the PT for each measured characteristic in accordance with Subsection 417-9(H), and utilizing Table 417-3 of the specifications will determine the pay factor for each measured characteristic.

In the event the contractor elects to question the mixture property test results, the contractor may request referee testing in accordance with Subsection 417-9(I) of the specifications.

(B) Ignition Furnace Correction:

Ignition furnace testing results shall be corrected in accordance with ADOT Materials Practice and Procedure Directive No. 20, "Guidance on the Use of Reclaimed Asphalt Pavement (RAP) in Asphaltic Concrete".

417-7.05 Compaction:

(A) Courses 1-1/2 Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F and the ambient temperature at the beginning of placement is at least 65 degrees F and rising. The placement shall be stopped when the ambient temperature is 70 degrees F or less and falling.

When Warm Mix Asphalt (WMA) technologies are not used in the mixture, asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, the recommended temperature range for compaction during production shall be shown on the mix design and shall be approved by the Engineer.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than 8 tons.

Pneumatic tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. Pneumatic tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic tired compactors shall be equipped with skirt-type

devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2 - 4*
Finish	Static Steel	Static Steel	1 - 3	1 - 3

Note:

* Based on the roller pattern which exhibits the best performance.

The Engineer shall select the option for compaction and, when pneumatic tired compactors are used, will designate the tire pressure.

One pneumatic tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of 1 inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

(B) Courses Greater than 1-1/2 Inches in Nominal Thickness:

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractor's responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

A compaction lot shall be identical to the mixture properties lot described in Subsection 417-7.04 of the specifications. Lots encompassing more than one project shall be separated in accordance with Subsection 417-9(D) of the specifications. Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. The Engineer will designate 10 random locations within the lot, and the contractor shall take two cores at each location; however, if more than one shift constitutes a lot, two cores shall be taken from a minimum of two random locations each shift, or as directed by the Engineer. The Engineer will save one core from each location for 15 days after written notification to the contractor of test results for the lot has been made. Randomly selected locations will be determined to the nearest 0.5 foot in the transverse direction and to the nearest foot in the longitudinal direction of the pavement course; however, the outside 1 foot of the unconfined pavement course will be excluded from testing as shown in ADOT Materials Practice and Procedure Directive (P.P.D.) No. 18, “Determining Sample Times and Locations for End Product Asphaltic Concrete”. Unless otherwise indicated in the project plans, shoulders shall be excluded from compaction lot testing on rehabilitation projects. Unless otherwise indicated in the project plans, placements without constant width including gore areas, tapers, and turn radii shall be excluded from compaction lot testing on all projects. P.P.D. No. 18 also addresses areas to be excluded relative to longitudinal joints. Areas excluded from testing will be compacted in accordance with Subsection 417-7.05(A) of the specifications. Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of AASHTO R 97. Cores shall be a minimum of 4 inches in diameter and shall be taken not later than two working days after placement of the asphaltic concrete. The cores shall be delivered to the Engineer immediately upon being taken. The bulk density of each core will be determined by the Engineer in accordance with the requirements of AASHTO T 166. The test results will be furnished to the contractor within four working days of receipt of cores by the Engineer. In areas where more than one lift is placed in the same lot, coring shall be accomplished through the full depth of the lifts after the final lift is placed, and the compaction density shall be based on the full depth of the lifts.

The target value for compaction shall be 5.5 percent in-place air voids. In-place air voids shall be determined in accordance with AASHTO T 269. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 417-7.04 of the specifications.

The Upper Limit (UL) is 8.0 percent in-place air voids and the Lower Limit (LL) is 3.0 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 417-9(H) of the

specifications, and utilizing Table 417-3 will determine the compaction pay factor.

In the event the contractor elects to question the core test results, the contractor may request referee testing in accordance with Subsection 417-9(I) of the specifications.

417-7.06 Smoothness and Surface Tolerances:

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13 of the specifications.

Regardless of whether testing in accordance with Subsection 109.13 of the specifications is specified or not, the following requirements shall be met:

(A) The surface of any lift of asphaltic concrete placed under this section of the specifications, other than the final lift, shall be tested and shall not vary by more than 1/4 inch from the lower edge of a 10-foot straightedge when it is placed in the longitudinal direction (including across transverse joints), and when it is placed in the transverse direction across longitudinal joints; and

(B) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

417-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement, and mineral admixture. Measurement will include any quantity used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

No separate measurement or payment will be made for mineral admixture, the cost being considered as included in the cost of the asphaltic concrete.

417-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate pay factors as hereinafter provided.

When Warm Mix Asphalt (WMA) technologies are used in the mixture, no separate payment will be made for WMA additives or technologies, necessary hot plant modifications, or other associated costs.

For the purpose of determining acceptability and appropriate pay factors, each unit of asphaltic concrete will be included in three separate lots: a “spread lot”, a “mixture properties lot”, and a “compaction lot”. The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture properties lot pay factor, and compaction lot pay factor.

The contractor may request to place the first lot of each mix type as a test strip. Requests to place a test strip shall be made in writing and acknowledged by the Engineer prior to start of production. A test strip shall be limited to 1,000 tons and may only be placed on shoulders, ramps, cross roads, or other areas approved by the Engineer. A test strip shall be excluded from the mixture properties lot pay factor and the compaction lot pay factor; however, all other provisions of Subsection 417-9 of the specifications shall still apply to such areas.

The Engineer may exclude asphaltic concrete from the spread lot and from the spread lot pay factor calculations if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots.

The Engineer may exclude certain locations from the mixture properties lot and/or the compaction lot and from the random sampling used in determining the mixture properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 417-7.03 of the specifications. If the quantity in a spread lot is found to vary by more than +5.0 percent from the required quantity, no payment will be made for the material which exceeds +5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than -12.0 percent from the required quantity, the spread lot will be rejected.

(B) Mixture Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

(1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 417-7.04 of the specifications;

(2) A single pay factor shall be determined for Gradation and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content; and

(3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed $3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 417-9(E) of the specifications shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be determined as set forth in Subsection 417-7.05(B) of the specifications.

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor, mixture properties lot pay factor, and compaction lot pay factor for each project shall be determined as follows:

(1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 417-7.03 of the specifications.

(2) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 417-7.04 of the specifications, regardless of which project(s) the samples fall within.

(3) PT values and pay factors for compaction, for those areas subject to Subsection 417-7.05(B) of the specifications, shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that Subsection;

(4) The mixture properties lot pay factor shall be determined separately for each project in accordance with Subsection 417-9(B) of the specifications, utilizing the individual pay factors determined in (2) above.

(5) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 417-9(C) of the specifications, utilizing the pay factor determined in (3) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within 25 days, or as agreed upon by the Engineer, after receiving notice that a spread lot, mixture properties lot, or compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus $1.00 per ton for spread lots, minus $5.00 per ton for compaction lots, minus $3.00 per ton for mixture properties lots in reject for Gradation only, minus $5.00 per ton for mixture properties lots in reject for Asphalt Cement Content and/or Effective Voids only, and minus $5.00 per ton for mixture properties lots in reject for Asphalt Cement Content and/or Effective Voids and also Gradation. Positive mixture properties lot pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place. In addition, for any mixture properties lot that is in reject due to Asphalt Cement Content but allowed to remain in place, payment shall not be made for asphalt cement quantities in excess of the upper limit (UL) as determined in Subsection 417-7.04(A) of the specifications.

The proposal shall contain an engineering analysis of the anticipated performance (i.e. reduction in serviceability, in years) of the asphaltic concrete if left in place. The engineering analysis shall also detail the potential root cause of the problem, any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall only include acceptance or referee test results, as applicable to the standards specifications. The engineering analysis shall include the expected additional cost to the Department (over original performance life) to maintain the pavement at an acceptable condition. The engineering analysis shall include supporting information such as pictures of the area, control charts, plant and field records, etc. The engineering analysis shall be performed by an independent professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected mixture properties lot or a rejected compaction lot is submitted for referee testing by the contractor, the 25 days allowed to prepare an engineering analysis will begin upon notification of referee test results.

The contractor may submit a written proposal without an engineering analysis for Engineer's evaluation and approval, that a mixture properties lot with a PT value lower than 50 on gradation and/or asphalt

cement content be allowed to remain in place if the application of a Self-Directed Target Change as outlined in Subsection 417-4 of the specifications would bring the PT value to 50 or greater. This written request shall also include the proposed revised PT calculations. Upon Engineer's verification and approval of the request, the material shall remain in place at the maximum negative pay factor(s) specified in this Subsection for the mixture properties lot in reject.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factor(s), and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

(1) The occurrence of two or more rejected lots within any 10 consecutive production lots;

(2) The occurrence of three consecutive negative mixture properties lot pay factors or three consecutive negative compaction lot pay factors; and/or

(3) The occurrence of five or more pay factors that are negative either for a mixture properties lot or for a compaction lot within any 10 consecutive production lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 417-4 of the specifications, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design or the course of action proposed in the engineering analysis, shall be implemented and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

No separate measurement or payment will be made for asphalt cement (bituminous material), the cost being considered as included in the cost of the asphaltic concrete.

A reduction in payment to the contractor for asphaltic concrete will be made for quantities of asphalt cement (bituminous material) that do not

meet the requirements of Section 1005 as determined by corresponding test results. Adjustments in payment shall be made in accordance with the requirements of Section 1005 of the specifications.

(G) Smoothness:

When required in the Special Provisions, payment for smoothness shall be made in accordance with the requirements of Subsection 109.13 of the specifications.

(H) Statistical Acceptance:

The "Total Percentage of Lot within UL and LL (PT)" shall be determined in accordance with Subsection 109.11 of the specifications.

Pay Factors (PF) shall be determined by entering Table 417-3 with PT.

TABLE 417-3
PAY FACTORS

Material Spread		Mixture Properties and Compaction			
			Pay Factors (Dollars per Ton)		
Negative Variance %	Pay Factor (Dollars per Ton)	PT	Gradation and Asphalt Cement Content	Effective Voids	Compaction
2.1 - 3.0	- 0.10	100	0.00	+ 2.00	+ 2.00
3.1 - 4.0	- 0.20	95 - 99	0.00	+ 1.00	+ 1.00
4.1 - 5.0	- 0.30	90 - 94	0.00	0.00	0.00
5.1 - 6.0	- 0.40	85 - 89	0.00	- 0.25	- 0.25
6.1 - 7.0	- 0.50	80 - 84	- 0.25	- 0.50	- 0.50
7.1 - 8.0	- 0.60	75 - 79	- 0.50	- 0.75	- 0.75
8.1 - 9.0	- 0.70	70 - 74	- 0.75	- 1.00	- 1.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25	- 1.25
10.1 - 11.0	- 0.90	60 - 64	- 1.50	- 1.50	- 1.75
11.1 - 12.0	- 1.00	55 - 59	- 2.00	- 2.00	- 2.25
More than 12.0	Reject	50 - 54	- 2.50	- 2.50	- 3.00
See Subsections 417-9(A) and (E)		Less than 50	Reject-See Subsection 417-9(E)		

(I) Referee Testing:

(1) Referee Testing Performed for Mixture Properties Only:

Within 15 days after written notification to the contractor of test results for a particular mixture properties lot, the contractor may make a written request for referee testing. The referee testing shall be performed by an independent approved laboratory designated by the Department. The

testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the test results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for the following properties:

Test Property	Test Method
Asphalt Cement Content	AASHTO T 308 (for both Non-RAP and RAP mixes)
Gradation	
Gyratory Density	AASHTO T 312 (See Note 1)
Maximum Theoretical Density	AASTHO T 209
Effective Voids	AASHTO T 269

Notes:

(1) Except compaction shall be performed to the number of gyrations specified for N-max in Note 4 of Table 417-1 and the density of the compacted specimens shall be calculated for N-design gyrations.

The results of the referee testing will be binding on both the contractor and the Department.

Using the referee testing results, the Engineer will determine new PT's for all characteristics.

When referee testing is performed on a mixture properties lot, the referee test result for the average maximum theoretical density will be used to determine a new PT for compaction.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties of that particular lot.

(2) Referee Testing Performed for Compaction Only:

Within 15 days after written notification to the contractor of test results for a particular compaction lot, the contractor may make a written request for referee testing. The bulk density of each of the cores previously saved will be determined in accordance with the requirements of AASHTO T 166 by an independent testing laboratory designated by the Department. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, or the test results by the Department. The percent air voids

will be determined in accordance with AASHTO T 269. The maximum theoretical density used in the determination of air voids will be the average of the four maximum theoretical densities determined for the lot in Subsection 417-7.04 of the specifications.

The results of the referee testing will be binding on both the contractor and the Department.

When referee testing is performed on a compaction lot, the Engineer will determine a new PT for compaction using the referee testing results.

The Department will pay for the referee testing; however, if the pay factor of the compaction lot does not improve or is reduced, or the compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete will be reduced by the amount of the cost of referee testing for the compaction of that particular lot.

(3) Referee Testing Performed for Both Mixture Properties and Compaction:

When referee testing is performed, as described above, for both the mixture properties lot and the compaction lot, the Engineer will use the referee test results to determine new PT's as specified in Subsections 417-9(I)(1) and 417-9(I)(2) of the specifications.

The Department will pay for the referee testing; however, if the combined pay factor of the lot (Mixture Properties plus Compaction) does not improve or is reduced, or if either the mixture properties lot or compaction lot remains in reject or is placed in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of the referee testing for the mixture properties and compaction of that particular lot.

SECTION 501 PIPE CULVERT AND STORM DRAINS:

501-1 Description:

The work under this section shall consist of furnishing pipe and all other materials required and the installing of pipe, including excavating, and furnishing, placing, and compacting backfill material, all in accordance with the details shown on the plans and the requirements of the specifications.

At each location where a pipe is to be installed, the project plans will specify the size and approximate length along with the requirements for each approved option at that location, such as the wall thickness, corrugation configuration, coatings, linings, class, and strength.

At each such specified location, pipe of one kind and material shall be selected by the contractor from the options shown. All contiguous pipe and all metal pipe in close proximity shall be of the same kind and material. Special sections, fittings, elbows, branch connections, tapered inlets, end sections, connectors, coupling, and other such items shall be of the same material and coating as the pipe to which they are attached unless otherwise stated in the specifications.

When trenching to depths in excess of 5 feet is required, prior to construction the contractor shall submit in writing to the Engineer a detailed description of its proposed trenching operations, including shoring methods.

501-2 Materials:

501-2.01 All Pipe Except Nonreinforced, Cast-In-Place:

Except for nonreinforced, cast-in-place concrete pipe, materials shall conform to the requirements of Section 1010 of the specifications.

501-2.02 Nonreinforced, Cast-In-Place:

Concrete for constructing the cast-in-place concrete pipe shall conform to the requirements of Section 1006 of the specifications for Class S concrete, except as specified herein.

Class S concrete shall have a minimum compressive strength of 3,000 pounds per square inch at 28 days.

The proposed slump in the mix design furnished by the contractor shall be the minimum required to permit proper placement of the concrete without harmful segregation, bleeding or incomplete consolidation.

The maximum size of the coarse aggregate for pipes 48 inches or less in diameter shall be 1 inch and for pipes larger than 48 inches in diameter shall be 1-1/2 inches.

501-3 Construction Requirements:

501-3.01 Preparation of Foundations, Trenches, and Embankments:

A trench condition is defined as a trench which has vertical slopes to a point at least 1 foot above the top of the pipe and its maximum width is as detailed on the plans.

Unless specified otherwise, the contractor may install pipe in either a non-trench condition or a trench condition in natural ground or in embankment.

Where rock, hardpan, or other unyielding material is encountered, such material shall be removed below the vertical limits as shown on the plans. The depth to be removed shall be at least 12 inches or as designated by the Engineer. The width to be removed shall depend on whether a trench or non-trench condition exists. If a trench condition exists, the width of the trench as shown on the plans shall be maintained throughout the additional depth. If a non-trench condition exists, the width of the removal shall be a minimum of the outside diameter of the pipe plus 2 feet for pipe under 4 feet in diameter, or a minimum of the outside diameter of the pipe plus 3 feet for pipe of 4 or more feet in diameter. The overexcavated area shall be backfilled with structure backfill material as designated in Subsection 203-5.03(B)(1) of the specifications and compacted in layers not exceeding 6 inches in depth.

When a firm foundation is not encountered at the bottom of the vertical limits as shown on the plans due to soft, spongy, or other unstable soil, such unstable soil shall be removed for a width of at least the horizontal outside dimension of the pipe on each side of the pipe and to the depth specified by the Engineer. The unstable soil removed shall be replaced with structure backfill material as designated in Subsection 203-5.03(B)(1) of the specifications and compacted in 6-inch lifts.

The completed foundation shall be firm for its full length and width. When specified on the project plans, the foundation shall have a longitudinal camber of the magnitude specified.

(A) Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) of the specifications when specified in the Special Provisions.

At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed:

(a) Bedding and backfill production, including crusher methods, pit extraction, and washing.

(b) Stockpile management, including stacking methods, separation techniques, stockpile pad thickness, and segregation prevention.

(c) Transporting and placing, including transport technique, lift thickness, processing and mixing technique, and compaction methods.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Backfill Material			
Gradation	AASHTO T 11 AASHTO T 27	Stockpile	1 per 500 CY per Source
PI	AASHTO T 89 AASHTO T 90	Stockpile	1 per 500 CY per Source
Proctor Density	AASHTO T 99	Stockpile	1 per Source and as needed
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	In-place	1 per 200 CY, minimum 1 per lift
Bedding Material			
Gradation	AASHTO T 11 AASHTO T 27	Stockpile	1 per 300 CY per Source
PI	AASHTO T 89 AASHTO T 90	Stockpile	1 per 300 CY per Source
Proctor Density	AASHTO T 99	Stockpile	1 per Source and as needed
Field Density	AASHTO T 191 AASHTO T 224 AASHTO T 272 AASHTO T 310	Stockpile	1 per 50 CY

501-3.02 Bedding:

(A) Bedding Material:

(1) General:

Bedding material for all pipe may be selected from excavation or from a source selected by the contractor and shall conform to the following aggregate gradation:

Sieve Size	Percent Passing
1-1/2 inch	100
1 inch	90 - 100
No. 8	35 - 80
No. 200	0 - 8.0

In addition to the above gradation requirements, thermoplastic pipe bedding material shall include no more than 50 percent passing a No. 100 sieve.

The plasticity index of the bedding material for all pipe shall not exceed 8 when tested in accordance with the requirements of AASHTO T 90.

Bedding material for all metal pipe shall have a value of resistivity not less than 2,000 ohm-centimeters unless otherwise specified or approved by the Engineer. Bedding material shall have a pH value between 6.0 and 10.0, inclusive, for all metal pipe installations except aluminum. Bedding material for aluminum pipe installations shall have a pH value between 6.0 and 9.0, inclusive. Bedding material shall have a pH value between 6.0 and 12.0, inclusive, for all concrete or plastic pipe installations. Tests for pH and resistivity shall be in accordance with the requirements of AASHTO T 288 and AASHTO T 289.

(2) Standard Aggregate Bedding Material:

Standard aggregate bedding material shall conform to the requirements specified in Subsection 501-3.02(A)(1) of the specifications, and shall be placed and mechanically compacted in 8 inch lifts as herein specified. Other methods of placement and compaction, including aggregate slurry and jetting shall require prior approval from the Engineer.

When an aggregate slurry mixture is allowed, the maximum water content shall be 35 gallons of water per ton of bedding material. Unless otherwise approved by the Engineer, the slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(D) of the specifications. Aggregate slurry shall be thoroughly mixed in a mixer approved by the Engineer.

(3) Cement-Treated Slurry Bedding Material:

Aggregate for cement-treated slurry bedding material, prior to the addition of cement and water, shall conform to the requirements specified in Subsection 501-3.02(A)(1) of the specifications. One sack of cement shall be added to each cubic yard of aggregate. Cement-treated slurry shall be thoroughly mixed in a mixer or at a central batch plant as approved by the Engineer and shall have a slump of 8 to 11 inches.

(B) Placement of Bedding Material:

(1) General:

All trash, forms, sheeting, bracing, and loose rock or loose earth shall be removed from the area into which bedding material is to be placed.

Bedding material shall be placed under and around the pipe from the bottom of the trench or bedding limits to the elevation at the point of maximum width of the pipe (springline), as shown on the plans. At the contractor's option, bedding material may be placed above the springline of the pipe, at no additional cost to the Department.

For pipes placed in a non-trench condition, as shown on the plans, standard aggregate bedding material shall be used from 6 inches below the pipe to the springline.

For pipes placed in trench condition, a 6-inch layer of standard aggregate bedding material shall be placed, in accordance with the plans, between the bottom of the trench and the bottom of the pipe. The remainder of the bedding, from the bottom of the pipe to the springline, shall be either standard aggregate bedding material or cement-treated slurry as tabulated below:

(a) For pipe culverts or storm drains 36 inches or larger, cement-treated slurry shall be used as bedding material from the bottom of the pipe to springline; or

(b) For pipe culverts or storm drains less than 36 inches in diameter, cement-treated slurry may be substituted for standard aggregate bedding material from the bottom of the pipe to springline.

Bedding material shall be placed in a manner which will prevent distortion, damage to, or displacement of the pipe from its intended location. Bedding material shall also be placed so that adequate support will be provided in the haunch support areas for the pipe. Voids or loose soils which are found to occur due to improper placement or compaction of bedding materials will result in rejection of that portion of the pipe installation. Replacement of the pipe will be at no additional cost to the Department.

(2) Standard Aggregate Bedding Material:

Standard aggregate bedding material shall be placed in uniform horizontal layers not exceeding 8 inches in depth before compaction. When aggregate slurry or jetting is allowed, bedding material shall be placed in uniform horizontal layers not exceeding 4 feet in depth.

(3) Cement-Treated Slurry Bedding Material:

Cement-treated slurry bedding material shall be placed in a uniform manner that will prevent voids in, or segregation of, the bedding material, and will not float or shift the culvert or pipe. Cement-treated slurry bedding material shall be placed from bottom of pipe to pipe

springline. No backfilling above the cement-treated slurry shall be commenced until 24 hours after the cement-treated slurry has been placed.

(C) Compaction of Bedding Material:

(1) General:

Compaction of bedding material shall be performed without damage to the pipe and surrounding in-place material. Special care shall be taken in placing, shaping and compacting all bedding material under haunches of pipe to prevent moving the pipe or raising it from its bedding.

(2) Standard Aggregate Bedding Materials:

Standard aggregate bedding material shall be compacted to at least 95 percent of the maximum density determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

When standard aggregate bedding material is allowed to be placed as an aggregate slurry or compacted by jetting, the material placed below the springline of the pipe shall be compacted prior to placement of material above the springline of the pipe.

Jetting shall not be used for any material placed more than 1 foot above the top of the pipe.

Ponding will not be permitted in any case.

When allowed, jetting shall be done in such a manner that water will not be impounded. Jetting methods shall be supplemented by the use of vibratory or other compaction equipment when necessary to obtain the required compaction. Bedding material compacted by jetting shall use the least amount of water that will properly consolidate the material and move the material under the pipe to eliminate voids. A jetting probe shall be inserted into the material. It shall be of such length as to reach the material under the pipe. Water shall be provided to the jetting probe at a minimum pressure of 30 pounds per square inch. The jetting probe shall be inserted at uniformly spaced intervals on both sides of the pipe, a maximum spacing of 3 feet.

When aggregate slurry or jetting is allowed, the contractor shall excavate holes in the compacted aggregate slurry or jetted bedding material to the depths and at the locations designated by the Engineer. These holes shall be of such size as to allow the required density testing to be performed in a safe manner. Upon completion of the tests, the contractor shall refill the excavated areas and compact the material to the required density in a manner satisfactory to the Engineer.

(3) Cement-Treated Slurry Bedding Material:

Cement-treated slurry bedding material shall not require additional compaction after placement up to pipe springline if it meets the material requirements of Subsection 501-3.02(A) of the specifications and is placed as outlined in Subsection 501-3.02(B) of the specifications. The Engineer may require the use of vibrators with cement-treated slurry bedding if the fluidity of the mixture is not sufficient to fill all voids. No density tests will be required in the cement-treated slurry bedding material as placed up to pipe springline.

501-3.03 Installation:

(A) General:

Pipe shall be handled carefully. Proper facilities shall be provided for handling and lowering the sections of pipe. All pipes which show defects due to negligence or rough handling shall be removed and replaced if so ordered by the Engineer. If damaged galvanized steel pipe is not replaced it shall be repaired in accordance with the requirements of AASHTO M 36. Damage to the coating of bituminous coated pipe shall be repaired using material conforming to the requirements of AASHTO M 190.

If the Engineer determines that the end of an existing pipe is damaged to the extent that it cannot be repaired sufficiently to be joined properly to the new pipe, the damaged portion shall be removed.

Pipe shall be installed in reasonably close conformity with the lines, grades and dimensions shown on the project plans or specified by the Engineer.

Prior to the staking of pipe culverts a study of the normal flow of the drainage shall be made. As a result of the study, a change in length or location of pipe may be required as approved by the Engineer to attain proper placement of the pipe. Pipe profiles shall be approved by the Engineer prior to constructing or installing each structure.

Unless otherwise permitted by the Engineer, the installing of the pipe shall begin at the downstream end.

Bell or groove ends of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream.

Helical corrugated pipe shall be installed with the separate sections firmly joined together with the corrugations in alignment.

Where there is restricted cover, the bolts of the bands connecting flexible pipe shall be advanced so that the tops of the bolts will be in line with or below the top of the pipe.

When aluminum alloys come in contact with concrete, the contacting surfaces shall be coated either with asphalt mastic conforming to the

requirements of AASHTO M 243 or with aluminum-impregnated caulking compound.

When specified on the project plans, the vertical diameter of round, flexible conduit shall be increased 5 percent by shop elongation.

Any pipe which is not in true alignment or which shows undue settlement after laying or is damaged shall be removed. The trench shall be prepared as hereinbefore specified and the pipe shall be installed again. Any pipe which, in the opinion of the Engineer, is damaged so that it cannot be used shall be replaced.

Paved or partially lined flexible pipe shall be installed so that the longitudinal center line of the paved segment coincides with the flow line. Elliptical and elliptically reinforced rigid pipe shall be installed with the major axis within 5 degrees of a vertical plane through the longitudinal axis of the pipe.

The interior of all pipes shall be free of dirt and foreign material as the work progresses and all pipes shall be left clean at the time of final acceptance.

Connections to new or existing pipes or structures shall be made in accordance with the details shown on the project plans or as may be ordered by the Engineer in order to complete the work specified.

When using metal safety end sections, the embankment slope shall be warped to match the end section.

For a skewed pipe installation, the toe of the embankment slope shall be warped to match the toe of the skewed metal safety end section in order to provide effective drainage.

When metal safety end sections are used, the bolts in the safety bars shall be torqued at 70 foot-pounds.

(B) Full Circle Corrugated Metal Pipe:

(1) General:

Field joints for each type of corrugated metal pipe shall provide circumferential and longitudinal strength to maintain the pipe alignment, prevent separation of the pipe, prevent infiltration of side fill material, and prevent leakage of water into the surrounding soil. Coupling bands and gaskets shall conform to the requirements of Subsection 1010-2.01 of the specifications.

Corrugations in the coupling bands shall have the same dimensions as the corrugations in the pipes being connected. Pipe fabricated with helical corrugations shall have the ends re-rolled to circumferential

corrugations to facilitate coupling. The re-rolled end shall extend a minimum of two corrugations from the end of the pipe.

When a new pipe is to be connected to the end of an existing in-place helical pipe, a coupling band with projections (dimples) may be used to make the connection.

Bands for pipe diameters to 72 inches, inclusive, and corrugation sizes of 2-2/3 by 1/2 inches or 3 by 1 inches shall be at least 10-1/2 inches wide. Bands for pipes 36 to 72 inches in diameter, inclusive, with corrugations 5 by 1 inches shall be at least 12 inches wide. Bands shall have two circumferential rows of projections. The rows of projections shall be spaced to provide equal contact on each side of the pipes being joined.

When bands with projections (dimples) are used to join new pipe to existing pipe, the joints shall be sealed with a continuous sponge rubber strip. The strip shall conform to the minimum requirements of ASTM D1056, Grade 2A1, and shall be at least 7 inches wide and 3/8 inch thick.

Where existing pipes are to be extended, the ends of the existing pipe shall be in such condition that the new pipe can be firmly joined to form an acceptable joint. All existing pipe ends that are damaged or are out of shape such that they cannot be joined in an acceptable manner shall be repaired.

Where prefabricated pipe fittings are to be installed in existing pipes, a portion of the existing pipe shall be removed in order to accommodate the fitting.

(2) Watertight and Water-resistant Joints:

Watertight joints shall be provided for siphon and irrigation pipe installation and when specified in the Special Provisions, standard drawings, or shown on the project plans. Watertight joints, unless otherwise specified, will not be required for storm drains, culverts, or other drainage pipe, however, joints for these pipes shall be water resistant.

Watertight and water-resistant joints shall conform to the requirements of Subsection 1010-2.01 of the specifications. When watertight joints are shown on the project plans or specified in the Special Provisions, the assembled joint shall pass a performance test, as specified herein or as approved by the Engineer, without significant leakage at the joint:

(a) A hydrostatic pressure test on a joint shall be made on an assembly of two sections of pipe, properly connected in accordance with the joint design. At the option of the contractor, suitable bulkheads shall be provided within the pipe adjacent to and on either

side of the joint, or the outer ends of the two joined pipe sections shall be bulkheaded. No mortar or concrete coatings, fillings, or packings in addition to that normally required for the joint shall be placed prior to watertightness tests. After the pipe sections are fitted together with the gasket or gaskets in place, the assembly shall be subjected to a pressure resulting from a head of 10 feet of water above the crown of the pipe for 10 minutes. Moisture of beads of water appearing on the surface of the joint will not be considered as leakage. The tests on individual joints may be performed at the fabricator's facility or at the job site.

The joint watertightness test shall be performed on pipe sections in straight alignment and on pipe sections deflected from straight alignment. When testing pipe sections not on straight alignment, the pipe sections shall be positioned to create a gap on one side of the outside perimeter of the pipe that is 1/2 inch wider than the gap for pipe sections in straight alignment. When coupling bands are used to test pipe sections not on straight alignment and the maximum gap on one side of the outside perimeter of the pipe is less than 1/2 inch wider than that for pipe sections in straight alignment, said coupling band pipe sections shall be positioned to provide maximum gap.

(b) Joints, other than watertight joints, which employ rubber gaskets, whether flat or "O" rings, will be considered water resistant. No testing will be required to establish that condition.

The contractor shall furnish to the Engineer a Certificate of Compliance, in accordance with the provisions in Subsection 106.05 of the specifications, that the material being furnished conforms to the joint property requirements as described herein. Field tests may be required by the Engineer whenever there is a question regarding compliance with these requirements.

(C) Slotted Pipe:

Slotted pipe shall be joined with coupling bands as shown on the project plans and the joint shall be made water resistant. Prior to attaching the coupling band, sealant material shall be placed between the coupling band and the periphery of the pipe section ends.

Prior to backfilling and paving operations, the slot shall be covered to prevent infiltration of material into the pipe. Heavy tape, roofing paper,

timber or other material may be used. Coverings shall be removed when the paving operations have been completed.

Slotted pipe shall be backfilled with grout in accordance with the details shown on the project plans. The grout shall conform to the requirements of Subsection 1010-3 of the specifications. Grout shall not be placed when a descending air temperature falls below 40 degrees F or until an ascending air temperature exceeds 35 degrees F. Temperatures shall be taken in the shade and away from artificial heat. The grout shall be cured in accordance with the requirements of Subsection 912-3.09 of the specifications.

(D) Precast Concrete Pipe:

Pipe sections shall be jointed such that the inner surfaces are reasonably flush and even, and the ends are centered as required.

Unless a particular type of joint is specified on the project plans, joints shall be made with Portland cement mortar, Portland cement grout, rubber gaskets, plastic sealing compound, or any other type approved by the Engineer.

Self-centering tongue and groove mortar joints shall be finished smooth on the inside. For diapered joints, diapers shall be used to retain the poured grout. Joints shall be thoroughly wetted before mortar or grout is applied.

When Portland cement mixtures are used, the completed joints shall be protected against rapid drying by means of an approved curing method. No joint shall be grouted until the following two sections of pipe are laid.

When required, watertight gasketed joints shall be installed on the pipe in accordance with the requirements of AASHTO M 198, Paragraph 5.1, or AASHTO M 315.

(E) Spiral Rib Corrugated Metal Pipe:

Spiral rib corrugated metal pipe shall be installed in accordance with the requirements specified in Subsection 501-3.03(B) of the specifications for full circle corrugated metal pipe, except as otherwise specified herein. Special care shall be taken during placement of the pipe and backfilling to avoid damage to the pipe.

Lateral field connections between metal pipes shall be welded and any galvanizing damaged by welding shall be coated with asphalt mastic conforming to the requirements of AASHTO M 243. Coupling bands shall be supplied in accordance with Subsection 1010-2.02(C) of the specifications.

The coupling bands used to connect spiral rib pipe sections shall be hugger-type bands, made from the same material as the pipe, or other

approved design, and shall be fitted with gaskets or "O" rings fabricated from neoprene or butyl rubber or other durable, resilient material approved by the Engineer, and assembled in such a manner as to form a sealed joint. "O" ring gaskets required for watertight joints shall be composed of rubber as specified in ASTM C361, Section 6.9, and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling band, in accordance with the manufacturer's installation instructions.

(F) Concrete-Lined Corrugated Metal Pipe:

Concrete-lined corrugated metal pipe shall be installed in accordance with the requirements specified in Subsection 501-3.03(B) of the specifications for full circle corrugated metal pipe, except as otherwise specified herein.

Pipe shall be joined with hugger-type bands which are 0.064 inches in thickness, of the same material as the pipe, and shall be two-piece for pipe greater than 48 inches in diameter.

Coupling bands, in addition to the requirements specified in Subsection 1010-2.03(A) of the specifications, shall be a minimum of 10-1/2 inches wide, formed with two corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by a minimum of two galvanized bolts, 1/2 inch in diameter, inserted in a bar held in place by a strap welded to the pipe. Bands drawn together by other connection arrangements, such as angles, shall not be allowed. "O" ring gaskets required for watertight joints shall be composed of rubber as specified in ASTM C361, Section 6.9, and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling bands in accordance with the manufacturer's installation instructions.

(G) Thermoplastic Pipe:

Thermoplastic pipe, which includes corrugated high-density polyethylene plastic pipe and corrugated polypropylene plastic pipe shall be assembled and installed in accordance with the manufacturer's instructions.

Watertight joints, unless otherwise specified, will not be required for storm drains, culverts, or other drainage pipes. However, joints for these pipes shall be water resistant. Watertight joints shall be provided for siphon and irrigation pipe installations.

Watertight and water-resistant joints shall conform to the requirements of Subsection 1010-8 of the specifications.

Tracer wire or tape for magnetic detection shall be placed in accordance with the requirements of Subsection 104.15 of the specifications.

To prevent damage and to assure that proper line and pipe grade are maintained throughout the backfilling operation, special care shall be taken in the handling and installation of corrugated high density polyethylene plastic pipe and fittings and corrugated polypropylene plastic pipe and fittings.

Thermoplastic pipe requires special bedding, backfill, and compaction requirements as specified in Subsections 501-3.02 and 501-3.04 of the specifications.

Thermoplastic pipe requires post installation inspection as specified in Subsection 501-3.08 of the specifications.

When end sections for the above listed pipes are called for on the plans, the contractor shall use metal safety end sections unless otherwise specified.

(H) Steel Reinforced Thermoplastic Pipe:

Steel reinforced thermoplastic pipe (i.e. steel reinforced high density thermoplastic ribbed pipe), shall be assembled and installed in accordance with the manufacturer's instructions.

Watertight joints, unless otherwise specified, will not be required for storm drains, culverts, or other drainage pipes. However, joints for these pipes shall be water resistant. Watertight joints shall be provided for siphon and irrigation pipe installations.

Watertight and water-resistant joints shall conform to the requirements of Subsection 1010-9 of the specifications.

To prevent damage and to assure that proper line and pipe grade are maintained throughout the backfilling operation, special care shall be taken in the handling and installation of steel reinforced thermoplastic pipe and fittings.

Steel reinforced thermoplastic pipe requires post installation inspection as specified in Subsection 501-3.08 of the specifications.

When end sections for steel reinforced thermoplastic pipe are called for on the plans, the contractor shall use metal safety end sections unless otherwise specified.

501-3.04 Backfilling and Compacting:

(A) Backfill Material:

(1) Pipe Backfill:

Pipe backfill material for concrete, corrugated metal, and steel reinforced thermoplastic pipes shall be selected from excavation or from a source selected by the contractor. It shall not contain frozen lumps, stones larger than 3 inches in diameter, chunks of clay or other objectionable material. Backfill material to be used for pipes, pipe-arches or arches made of metal shall have a value of resistivity not less than 2,000 ohm-centimeters or the value shown on the project plans. When resistivity is not shown on the plans, the backfill material shall have a value of resistivity not less than that of the existing in-place material or 2,000 ohm-centimeters, whichever is less. Backfill material shall have a pH value between 6.0 and 10.0, inclusive, for all metal pipe installations, except aluminum. Backfill material for aluminum pipe installations shall have a pH value between 6.0 and 9.0, inclusive. Backfill material shall have a pH value between 6.0 and 12.0, inclusive, for all concrete or plastic pipe installations. Tests for pH and resistivity shall be in accordance with the requirements of AASHTO T 288 and AASHTO T 289.

Pipe backfill material for concrete, corrugated metal, and steel reinforced thermoplastic pipes shall conform to the following gradation:

Sieve Size	Percent Passing
3 inch	100
3/4 inch	60 - 100
No. 8	35 - 80
No. 200	0 - 12.0

In addition to the above gradation requirements, steel reinforced thermoplastic pipe backfill material shall not contain particles with a maximum dimension larger than 1-1/2 inch.

The plasticity index shall not exceed 12 when tested in accordance with the requirements of AASHTO T 90.

As an alternate, pipe backfill may conform to the material requirements listed for bedding material as specified in Subsection 501-3.02(A) of the specifications, for standard aggregate bedding material or cement-treated slurry bedding material.

Pipe backfill for thermoplastic pipe shall conform to the material requirements listed for thermoplastic pipe bedding material as specified in Subsection 501-3.02(A) of the specifications, for standard aggregate bedding material or cement-treated slurry bedding material.

(2) Trench Backfill:

Trench backfill material shall not contain organic material, rubbish, debris, and other deleterious material and shall not contain solid material which exceeds 8 inches in greatest dimension and shall be soil selected from excavation or from a source selected by the contractor.

As an alternate, trench backfill may conform to the material requirements listed for bedding material as specified in Subsection 501-3.02(A) of the specifications for standard aggregate bedding material or cement-treated slurry bedding material.

(3) Slope Plating:

The roadway slope at the inlet ends of pipe culverts shall be plated with an impervious material. The plating material shall be a fine-grained, cohesive material with at least 50 percent of it passing the No. 40 sieve and with a plasticity index of at least 10 and shall be placed as shown on the plans. The plasticity index will be determined in accordance with the requirements of AASHTO T 90.

(B) Placement of Backfill Material:

(1) General:

All trash, forms, sheeting, bracing, and loose rock or loose earth shall be removed from the areas to be backfilled before backfill material is placed.

Backfill compacted by pneumatic or mechanical tamping devices, shall be placed in layers not more than 8 inches in depth before compaction.

Pipe backfill shall be brought up evenly on both sides of the pipe for the full length to an elevation 1 foot above the top of the pipe.

Trench backfill shall be placed from 1 foot above the top of the pipe to the elevation at which base or surfacing materials are to be placed or to the top of the trench.

Backfill material shall be placed around and over arches in accordance with the requirements of Section 502 of the specifications.

(2) Standard Aggregate Slurry:

With prior approval from the Engineer, pipe backfill may be placed as an aggregate slurry as herein specified. Pipe backfill or trench backfill mixed as a standard aggregate slurry shall be placed in uniform horizontal layers not exceeding 4 feet in depth. The slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(D) of the specifications.

(3) Cement-Treated Slurry:

Cement-treated slurry pipe backfill placement above springline shall not commence within 24 hours of the placement of the underlying cement-treated bedding material below springline. Cement-treated pipe backfill shall be placed in a uniform manner that will prevent voids in or

segregation of the backfill to an elevation 1 foot above the top of the pipe. No backfilling above the cement-treated slurry pipe backfill shall be commenced until 24 hours after the cement-treated slurry has been placed.

If cement-treated slurry bedding material is used for trench backfill, it shall not be disturbed or loaded in any manner within 24 hours of placement as above.

(C) Compaction of Backfill Material:

Backfill material shall be compacted to at least 95 percent of the maximum density determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Jetting shall not be used to compact pipe backfill, trench backfill, or any material placed more than 1 foot above the top of the pipe.

Ponding will not be allowed in any case.

If trench backfill or pipe backfill is allowed to be placed as an aggregate slurry, the contractor shall excavate holes in the compacted slurry to the depths and at the locations designated by the Engineer. These holes shall be of such size as to allow the required density tests to be performed in a safe manner. Upon completion of the tests, the contractor shall refill the excavated areas and compact the material to the required density in a manner satisfactory to the Engineer.

Cement-treated slurry bedding material for pipe backfill shall not require additional compaction after placement up to an elevation 1 foot above the top of pipe if it meets the material requirements of Subsection 501-3.02(A) of the specifications and is placed and compacted as outlined in Subsection 501-3.04(B) and (C) of the specifications. No density tests will be required in the cement-treated slurry bedding material when it is utilized for pipe backfill to an elevation 1 foot above the top of pipe.

Cement-treated slurry bedding material used for trench backfill shall meet the requirements listed above for pipe backfill up to the elevation which it is placed.

501-3.05 Filter Material:

When shown on the project plans or specified in the Special Provisions, filter material shall be carefully placed around perforated pipe.

Filter material shall conform to the grading requirements for fine aggregate in Section 1006 of the specifications and shall be placed in accordance with the details shown on the project plans.

501-3.06 Encasement of Pipe:

When shown on the project plans, pipe shall be encased in Class B concrete. Portland cement concrete shall conform to the requirements of Section 1006 of the specifications.

501-3.07 Nonreinforced, Cast-In-Place Concrete Pipe:

(A) General Requirements:

The contractor shall have previously installed cast-in-place pipe similar to the pipe specified in this contract. The Engineer may require the contractor to submit a list of names of the contractor's key personnel with their cast-in-place pipe experience. When required, the list shall include the foreman and equipment operators.

When the project plans include cast-in-place concrete pipe as an alternate, the contractor shall review the geotechnical investigation report. The geotechnical investigation reports are available on the ADOT Contracts and Specifications Group Current Advertisements website. The contractor shall be responsible to determine if the in-place soil conditions will allow the specified trench to be constructed.

The contractor shall provide a quality control administrator who shall be responsible for cast-in-place pipe quality. The administrator shall be a full-time employee of the contractor or a consultant engaged by the contractor. The contractor shall provide documentation to the Engineer which demonstrates the quality control administrator's experience in the manufacture and placement of cast-in-place pipe. The administrator shall have the authority to control all activities necessary to ensure a product of acceptable quality, including strength, alignment, thickness, and grade.

The contractor's quality control administrator shall inspect the pipe construction and complete a daily observation form, supplied by the Engineer. The form shall be completed and submitted to the Engineer no later than 9:00 a.m. on the first working day following each day work is being performed on the pipe installation.

Nonreinforced, cast-in-place concrete pipe shall be cast monolithically in a prepared trench at the locations and in accordance with the details shown on the project plans and the requirements of these specifications.

The pipe shall be constructed with equipment specifically designed for constructing cast-in-place, monolithic concrete pipe. The equipment shall be approved by the Engineer prior to use, and the contractor may be required to furnish evidence of successful operation of the equipment on similar work. If, in the opinion of the Engineer, the equipment furnished is not suitable to produce the quality of work specified, its use will not be permitted for the work.

Pipe shall be constructed in trenches which have been excavated in either native soil or compacted fill. The trench walls shall be stable so that the planned shape of the trench is maintained.

The minimum inside diameter of the pipe, measured in any direction, shall be at least 98 percent of the nominal pipe size. The minimum wall thickness will be as specified on the project plans for each pipe size.

(B) Excavation:

The trench shall be excavated to the lines and grades shown on the project plans. Laser guided alignment instruments shall be used to control the grade and alignment of the trench. Departure from and return to the established grade for the finished trench shall not exceed 1 inch per 10 linear feet, with a total departure not to exceed 1.5 inches. Departure from and return to specified alignment for the trench shall not exceed 2 inches per 10 linear feet, with a total departure not to exceed 4 inches. The bottom of the trench shall be shaped in accordance with the details shown on the project plans and prepared to provide full, firm, and uniform support over the bottom 210 degrees of the pipe to be constructed.

The length of trench permitted to remain open at any one time shall not exceed 1,600 linear feet, unless otherwise specified in the Special Provisions or as may be permitted by the Engineer.

The bottom of the trench must consist of either undisturbed native soil or compacted backfill.

When, in the opinion of the Engineer, soft, spongy, or other unsuitable material is encountered in the bottom of the trench, such unsuitable material shall be removed to the depth and width directed by the Engineer. The resulting area shall be backfilled with material conforming to the requirements of Subsection 501-3.04(A)(1) of the specifications. The backfill shall be compacted in accordance with the requirements of Subsection 501-3.04(C) of the specifications. The trench shall then be excavated as specified above.

When boulders, bedrock, or rock ledges are encountered in the bottom or side walls of the trench, such material shall be removed to a distance of at least 6 inches from the nearest surface of the pipe, and the space then backfilled, compacted, and reshaped as required above for unsuitable material.

The trench walls, from a point 1 foot above the top of the pipe to the top of the trench, may be sloped as required by soil conditions to provide more stability in the trench and safer working conditions in accordance with the provisions of Subsection 107.07 of the specifications. The steepness of the side slopes shall be limited to the degree of stability considered necessary for safety, unless an approved shoring system is

used. Side slopes shall conform to current OSHA regulations and be approved by the Engineer.

(C) Concrete Placement:

At the time of concrete placement, all surfaces in the trench which will be in contact with the pipe shall be thoroughly moistened so that moisture will not be drawn from the freshly placed concrete; however, the trench shall be free of standing water, mud, and debris.

The concrete shall be placed around the full circumference of the pipe in one operation. When metal forms are used, they shall be of sufficient strength to withstand vibrating and tamping of the concrete.

The concrete shall be vibrated, rammed, tamped, or worked with suitable devices until the concrete has been thoroughly consolidated and completely fills the formed space.

Laser guided alignment instruments shall be used to control the grade and alignment of the pipe. Departure from and return to the established grade for the invert of the installed pipe shall not exceed 1 inch per 10 linear feet, with a total departure not to exceed 1.5 inches. The surface of the invert shall not vary by more than 0.10 feet when tested with a 10-foot straight edge. Departures from and return to specified alignment for the pipe shall not exceed 2 inches per 10 linear feet, with a total departure not to exceed 4 inches.

When placing operations stop for such a time that initial set of the concrete is likely to occur before placement resumes, a construction joint shall be made by leaving the end of the pipe rough with a slope of approximately 45 degrees and inserting 24-inch No. 4 dowels 1 foot into the center of the pipe wall at approximately 18-inch intervals.

Collars may be used in lieu of doweled joints. An excavation shall be made along the sides and bottom of the construction joint to permit casting of a concrete collar around the outside of the joint. The collar shall have a minimum thickness 1.25 times the pipe wall thickness and shall lap the entire joint by at least two times the wall thickness.

Immediately before resuming concrete placement, the joint shall be cleaned of all laitance, loose, or defective concrete, coatings and other deleterious materials, and thoroughly wetted.

Construction joints used for connections to another pipe or at junction structures shall be made by squaring off the end of the pipe. An excavation along the sides and bottom of the pipe to permit casting of the concrete collar shall be made as previously specified.

After the removal of forms, the inside of the pipe will be inspected for rock pockets, voids, form indentation, and excessive form lap. Any necessary repairs shall be made within 24 hours and to the satisfaction

of the Engineer. Cracks shall be repaired in accordance with Subsection 501-3.07(G) of the specifications.

(D) Finishing:

The interior surface and exterior top surface of the pipe shall be as smooth as a wood-float finish and shall be essentially free of fractures, cracks, and roughness.

(E) Curing:

Within 15 minutes after the pipe is cast, the concrete forming the exposed top portion of the pipe shall be cured as follows:

The pipe shall be covered with a polyethylene film conforming to the requirements of AASHTO M 171 except that the nominal thickness shall be 0.0015 inches. The film shall be white opaque or clear and shall be held in place with loose soil to assure continuous contact. The loose soil shall not be greater than 6 inches in depth at any point and shall conform to the requirements herein before specified under pipe backfill. This curing method shall be used when the ambient temperature exceeds 100 degrees F.

For ambient air temperatures equal to or less than 100 degrees F, the pipe may be sprayed with a liquid membrane-forming compound conforming to the requirements of Subsection 1006-6.01(C) of the specifications. If the contractor elects to spray the pipe with a liquid membrane, such procedure shall be completed within 30 minutes.

During the curing period, the inside of the pipeline shall be kept in a humid condition for at least seven days following placement of the concrete. To prevent air drafts from drying the fresh concrete, openings in the pipeline shall be covered during the seven-day period, except at locations where work on the pipe is required and only during the time that such work is actually in progress.

(F) Backfilling:

Backfilling shall not start until the concrete has developed a compressive strength of at least 2,500 pounds per square inch.

The type of backfill material, the placement of pipe and trench backfill material, and compaction shall conform to the requirements of Subsection 501-3.04 of the specifications.

(G) Pipe Repair:

The contractor shall perform all interior crack repairs only after backfilling.

Transverse cracks 0.05 inches or more in width shall be cleaned and filled with an elastomeric compound approved by the Engineer. The elastomeric compound shall penetrate into the crack at least 0.38 inches.

A longitudinal crack shall be defined as one which is generally oriented within 30 degrees of the alignment of the pipe.

Longitudinal cracks will be a cause for rejection under any of the following conditions:

(1) A crack which has caused a surface fault within the pipe with a displacement greater than 0.08 inches;

(2) A crack width greater than that determined by the formula 0.0005 x O.D. and that can be penetrated by a standard machinist gauge leaf designated in AASHTO T 280; and/or

(3) A crack width greater than 0.05 inches and that can be penetrated by a standard machinist gauge leaf designated in AASHTO T 280.

Longitudinally cracked pipes meeting any of the three rejection criteria above may be allowed to remain in place if approved by the Engineer. If the Engineer allows such rejectable pipe to remain, all longitudinal cracks meeting any of the three criteria above shall be repaired by full depth epoxy grouting.

Any section of pipe rejected by the Engineer shall be removed and replaced at no additional cost to the Department.

(H) Pipe Wall Thickness:

The contractor shall measure the thickness at the invert and crown by probing at 25-foot intervals during the placement of concrete. The probe shall be a 3/8-inch round bar at least 2 inches longer than the wall thickness to be measured. The measurements shall be reported on the daily observation form.

The wall thickness will be measured for acceptance. One hole each shall be drilled at the invert and on each side of the springline, within 200-foot intervals. The drill locations will be determined by the Engineer. The Engineer may require additional holes on curves or in areas which appear to be defective. All holes shall have a minimum diameter of 3/4 inch. If the wall thickness is less than the specified minimum thickness, a core shall be drilled adjacent to the drilled hole.

All cores shall have a minimum diameter of 3 inches.

The length of the core will be determined in accordance with the requirements of AASHTO T 148.

If the length of the drilled core is deficient, additional cores shall be taken at intervals not to exceed 10 feet in each direction from the deficient core until one core which is not deficient is obtained in each direction. The pipe between these two acceptable cores will be rejected. The rejected pipe section shall be removed and replaced with pipe of the specified thickness at no additional cost to the Department.

At all locations where drilled holes or cores have been made, the resulting holes shall be filled with concrete in a manner satisfactory to the Engineer.

501-3.08 Post Installation Inspection of Thermoplastic Pipe:

A post installation inspection of all thermoplastic pipe and steel reinforced thermoplastic pipe shall be conducted by the contractor no sooner than 30 days after completion of installation and final fill, excluding pavement. Pipes shall be checked for deflection using a mandrel, or other device approved by the Engineer capable of physically verifying interior dimensions of the pipe. Pipes larger than 24 inches may be entered following OSHA requirements, and deflection levels may be measured directly.

The contractor shall notify the Engineer at least seven days in advance of any pipe inspections.

Mandrels used for deflection testing shall be a nine (or greater odd number) arm mandrel, sized to 95 percent of the Certified Mean Inside Diameter (CMID) of the pipe to be tested. CMID shall be as provided by the pipe manufacturer. The contractor shall provide a properly sized proving ring to the Engineer for verifying mandrel size prior to testing. The contractor shall use rope or cable to manually pull the mandrel through the entire pipe. Any pipe not allowing passage of the mandrel shall be reported to the Engineer.

When direct measuring is used for deflection testing, the contractor shall take rise and span measurements every 10 feet for the full length of pipe. Measurements shall be taken at a minimum of four locations for shorter pipes. The contractor shall report to the Engineer any rise or span measurements that are less than 95 percent of the CMID.

Pipes with more than 5 percent deflection shall be removed, replaced and re-inspected at contractor’s expense. Pavement and other features affected by the pipe removal shall be removed and replaced at contractor’s expense.

501-4 Method of Measurement:

Pipe will be measured by the linear foot parallel to the central axis of the pipeline and shall include the length of fittings.

Tees, wyes, and other branches will be measured as pipe along the central axis of the pipes to the point of intersection of said central axes. Pipe reducers will be measured as pipe of the larger diameter along the central axis.

The end of pipe in closed structures will be considered to be at the intersection of the central axis and the inside face of the wall and for masonry and concrete headwalls it will be considered to be at the intersection of the central axis and the face of the headwall.

End sections will be measured by the number of units installed.

501-5 Basis of Payment:

The accepted quantities of pipe, measured as provided above, will be paid for at the contract unit price complete in place.

Except as hereinafter specified, no separate measurement or payment will be made for excavating trenches and for furnishing, placing, and compacting bedding and backfill material as described and specified herein and on the project plans, the cost thereof being considered as included in the contract unit price per foot of pipe.

Payment for the removal of rock, hard pan, other unyielding material, or soft, spongy, or other unstable soil below the vertical limits as shown on the plans, and the backfilling of these over-excavated areas, as specified herein and as directed by the Engineer, will be paid for in accordance with the requirements of Subsection 104.02 of the specifications.

When an embankment is constructed prior to the digging of a trench and the installation of a pipe, payment for the construction of the embankment will be made under the appropriate item, such as Roadway Excavation or Borrow. Removal of rock, hard pan, other unyielding material, or soft, spongy, or other unstable material from the trench within the embankment will not be considered for payment.

The repairing of the damage to existing pipe ends to which new pipe is to be joined and which cannot be seen in order to be assessed and the removal of any portion of a damaged existing pipe, as specified under Subsection 501-3.03(B) of the specifications will be paid for in accordance with the provisions of Subsection 104.02 of the specifications.

No measurement or direct payment will be made for furnishing and placing filter material, plating material, fittings, collars, bands, and the joining of new and existing pipes.

For cast-in-place pipe, no separate measurement or payment will be made for the excavation or preparation of the trench; for furnishing, placing, and compacting backfill material; for pipe repair, when authorized by the Engineer; or for quality control activities; the cost being considered as included in the unit price per foot of pipe.

For thermoplastic pipe and steel reinforced thermoplastic pipe, no separate measurement or payment will be made for post installation inspection, the cost being considered as included in the unit price per foot of pipe.

End sections, measured as provided above, will be paid for at the contract unit price complete in place.

SECTION 502 STRUCTURAL PLATE PIPE, PIPE-ARCHES, AND ARCHES:

502-1 Description:

The work under this section shall consist of furnishing and erecting structural plate pipe, pipe-arches, and arches of the sizes, thicknesses, and dimensions shown on the project plans. They shall be installed at the locations specified on the project plans or as directed by the Engineer in reasonably close conformity to the lines and grades shown on the project plans or as established by the Engineer and the requirements of these specifications.

502-2 Materials:

Materials shall conform to the requirements of Section 1010 of the specifications, unless otherwise specified.

Plates shall be fabricated in accordance with the requirements of either AASHTO M 167, AASHTO M 219 or Federal Specification WW-P-405.

Concrete shall conform to the requirements of Section 1006 of the specifications for the class and strength shown on the project plans.

Reinforcing steel shall conform to the requirements of Section 1003 of the specifications.

502-3 Construction Requirements:

Excavating bedding and backfilling for the structural plate pipe, pipe-arches, and arches shall be performed as specified under Section 501 of the specifications and as specified herein and on the project plans. Excavating and backfilling for the concrete footings shall be performed as specified under Subsection 203-5 of the specifications. Placement

of reinforcing steel and structural concrete shall conform to the requirements of Sections 605 and 601 of the specifications, respectively.

When backfill material is placed around and over arches before headwalls are in place, the material shall first be placed midway between the ends of the arch, forming as narrow a ramp as possible, until the top of the arch is reached. The ramp shall be constructed evenly from both sides and the material shall be compacted as it is placed. After the two ramps have been constructed to the top of the arch, the remainder of the material shall be placed from the top of the arch both ways from the center to the ends and as evenly as possible on both sides of the arch.

When the headwalls are constructed before any backfill material is placed around and over the arch, the material shall first be placed adjacent to one headwall until the top of the arch is reached after which it shall be dumped from the top of the arch toward the other headwall and as evenly as possible on both sides of the arch.

In multiple installations, extreme care shall be taken so that the backfill material is brought up evenly on each side of each arch so that unequal pressures will be avoided.

Plates shall be formed to provide lap joints with the upstream plate lapping over the downstream plate. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the project plans.

Plates for forming skewed or sloped ends shall be cut to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs and shall present a workmanlike finish. Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

Steel plates shall be punched so that bolt holes along those edges of the plates that will form longitudinal seams in the finished structure will be staggered in rows 2 inches apart, with one row in the valley and one on the crest of the corrugation. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of plate shall be not less than 1.75 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch.

Aluminum plates shall be punched so that bolt holes along those edges of the plates that will form longitudinal seams in the finished structure will be on a double row with a center-to-center dimension of 1-3/4 inches. In all structures the longitudinal seam shall be comprised of two bolts in each valley and crest of each corrugation. The standard center-to-center dimensions of bolt holes that will form the circumferential seam

in the finished structure shall be 9-5/8 inches. The minimum distance from the center of hole to the edge of the plate shall not be less than 1.75 times the diameter of the bolt.

Tolerance of all hole diameters and spacing shall be as indicated on the project plans or in the Special Provisions.

Plates shall be erected in their final position by connecting the plates with bolts at longitudinal and circumferential seams. Drift pins may be used to facilitate matching of holes. All plates shall be placed in the order recommended by the manufacturer with joints staggered so that not more than three plates come together at any one point. All bolts shall be drawn tight, without overstress, before beginning the backfill.

Steel bolts for structural-plate sections shall be torqued during installation to a minimum of 100 foot-pounds and a maximum of 300 foot-pounds.

For power-driven tools, the hold-on period may vary from two to five seconds. The bolts for aluminum structural-plate sections shall be torqued during installation to a minimum of 100 foot-pounds and a maximum of 200 foot-pounds. Bolts shall be of sufficient length to provide a full nut.

After structural plate pipe has been erected, all spots where damage has occurred to spelter shall be given two coats of an approved hot asphalt paint, or shall be wire brushed and given two coats of zinc paint, as specified in Section 1002 of the specifications, as directed by the Engineer.

502-4 Method of Measurement:

Structural plate pipe, pipe-arches, and arches will be measured either by the linear foot, or by the lump sum for each structure, installed in place, completed, and accepted.

If measurement is made by the linear foot, measurement will be made along the invert center line for pipe and pipe-arches and the average of the springline lengths for arches.

Structural concrete and reinforcing steel used for headwalls and footings will be measured by the cubic yard and by the pound, respectively.

Structural excavation and structure backfill for footings will be measured in accordance with the requirements of Subsection 203-5.04 of the specifications.

502-5 Basis of Payment:

The accepted quantities of work under this section, measured as provided above, will be paid for at the contract lump sum price or the contract unit price per linear foot for the different sizes and thickness of structural plate pipe, pipe-arches and structural plate arches designated in the bidding schedule, complete in place, including excavating and furnishing, placing, and compacting backfill material.

Payment for structural concrete used in footings and headwalls will be made as provided in Subsection 601-6 of the specifications. Payment for reinforcing steel used in footings and headwalls will be made as provided in Subsection 605-5 of the specifications. Payment for structural excavation and structure backfill for footings will be made as provided in Subsection 203-5.05 of the specifications.

SECTION 503 CONCRETE CATCH BASINS:

503-1 Description:

The work under this section shall consist of furnishing all materials and constructing or reconstructing concrete catch basins, including excavation, concrete removal, and backfill. Work shall be done at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

503-2 Materials:

503-2.01 Concrete:

Portland cement concrete shall conform to the requirements of Section 1006 of the specifications for Class B concrete.

503-2.02 Reinforcing Steel:

Reinforcing steel bars or mesh shall conform to the requirements of Section 1003 of the specifications.

503-2.03 Masonry Mortar:

Masonry mortar shall be composed by volume of one part Portland cement, two parts fine aggregate, one-fifth part hydrated lime, and sufficient water to provide a plastic mixture. The lime shall be considered as an addition to and not as replacing any cement.

Fine aggregate shall conform to the requirements of ASTM C144. Portland cement and water shall conform to the requirements of Section 1006 of the specifications. Hydrated lime shall conform to the requirements of ASTM C207, Type N.

Mortar that has been mixed more than one hour shall not be used. Retempering of mortar will not be permitted.

503-2.04 Structural Steel:

Structural steel parts shall conform to the requirements of Section 1004 of the specifications.

503-3 Construction Requirements:

503-3.01 Catch Basins:

Excavation and backfill for the catch basin shall be performed in accordance with the requirements of Subsection 203-5 of the specifications.

Catch basins shall be cast-in-place or, at the option of the contractor, may be precast units. A list of approved precast units may be found on the Department's Approved Products List (APL), available on the internet from the Arizona Transportation Research Center (ATRC), through its Product Evaluation Program.

The "H" dimension for catch basins shall be determined in the field prior to casting. The contractor is advised to acquaint itself with conditions peculiar to the project which might limit the use of precast items.

Cast-in-place catch basins shall be constructed in accordance with the requirements of Section 601 of the specifications and reinforced where called for on the plans in accordance with the requirements of Section 605 of the specifications in reasonably close conformity to the lines and grades shown on the plans and shall meet adjacent sidewalk, curb, or gutter surfaces with no appreciable offsets. Catch basin grates and frames shall be fabricated and installed so that the bearing surfaces of the grate rest securely on the bearing surfaces of the frame.

Proper equipment shall be provided for lowering the precast sections to position. The tongue end of the section shall be placed in contact with the base structure unless otherwise directed. Not more than two holes shall be cast or drilled in the shell of each section for the purpose of handling and placing. If such holes are provided, they shall be filled and finished with mortar after placing the catch basins. Immediately before joining precast sections, mortar shall be placed continuously around the circumference of the receiving section's contact surface. Any precast section damaged during handling or placing shall be repaired or replaced at the option of the Engineer and at no additional cost to the Department.

When specified on the project plans, aprons shall be constructed in accordance with the details shown on the plans. Aprons shall be constructed from Portland cement concrete or from asphaltic concrete.

When specified on the project plans or ordered by the Engineer, corrugated metal pipe shall be installed as temporary drain for the roadway. The pipes shall be subsequently filled with concrete.

Backfilling of the completed structure shall be in accordance with the requirements of Subsection 203-5 of the specifications.

Preformed bituminous joint filler shall be installed where the catch basin concrete will meet new or existing concrete curb pavement.

503-3.02 Reconstruct Catch Basins:

Catch basins shall be reconstructed in reasonably close conformity to the lines and grades shown on the plans. The existing frame and grate shall be carefully removed and cleaned. After removal of the frame, the top of the catch basin shall be trimmed to provide a suitable foundation for the new material. Frames and grates shall then be reinstalled according to the requirements of Subsection 503-3.01 of the specifications.

Where reconstruction of a catch basin requires partial removal of concrete, sufficient concrete shall be removed to permit new reinforcing steel to be spliced to existing reinforcing steel in accordance with the requirements of Subsection 605-3.02 of the specifications. Existing reinforcing incorporated into the new work shall be thoroughly cleaned of all adhering material before being embedded in new concrete. New concrete shall be placed according to the requirements of Section 601 of the specifications.

503-3.03 Frame and Grate:

The fabrication of frame and grate units shall conform to the requirements of Subsection 604-3.06 of the specifications.

When reconstruct catch basin is specified, in accordance with Subsection 503-3.02 of the specifications, and when an existing frame and grate is unsuitable for further use, a new frame and grate shall be furnished and installed. Where an existing frame and grate is suitable for reuse but is either lost or damaged by the contractor's operations to the extent that it is unacceptable for reuse, it shall be replaced at no additional cost to the Department.

503-4 Method of Measurement:

Catch basins will be measured as a unit for each catch basin, including frame and grate; for each catch basin reconstructed; or for each frame and grate furnished.

503-5 Basis of Payment:

The accepted quantities of catch basins, of reconstruct catch basins, and of frame and grate for catch basin, measured as provided above, will be paid for at the contract unit price each, complete in place, including aprons, temporary construction drains, excavation and backfill.

The removal of unsuitable material below the required depth and the furnishing and placing of material in the voids thus created will be paid for in accordance with the provisions of Subsection 104.02 of the specifications.

SECTION 504 STANDPIPES:

504-1 Description:

The work under this section shall consist of furnishing all materials and constructing standpipes for irrigation or drainage pipes, including excavation, backfill, covers, and gates, at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

504-2 Materials:

504-2.01 Concrete:

Concrete shall be Class B Portland cement concrete conforming to the requirements of Section 1006 of the specifications.

504-2.02 Concrete Pipe:

Concrete pipe materials shall conform to the requirements of Section 1010 of the specifications.

504-2.03 Mortar:

Mortar for pipe joints shall conform to the requirements of Subsection 503-2.03 of the specifications.

504-2.04 Metal Covers:

Materials furnished for structural steel plate and bars in steel plate covers shall conform to the requirements of Section 1004 of the specifications for structural carbon steel.

504-2.05 Metal Gates:

Materials furnished for metal gates shall conform to the requirements specified on the plans or in the Special Provisions.

504-3 Construction Requirements:

For a standpipe using reinforced concrete pipe, the pipe shall be placed so that the bell or grooved end is uppermost to receive the cover. All connections to new or existing pipes will be considered as being a part of the standpipe. Mortar joints shall be made in accordance with the details shown on the plans and shall be watertight.

Concrete standpipes shall be constructed in accordance with the requirements of Section 601 of the specifications.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of the specifications.

504-4 Method of Measurement:

Standpipes, of the types specified on the project plans, will be measured as a unit for each type constructed.

504-5 Basis of Payment:

The accepted quantities of standpipes, measured as provided above, will be paid for at the contract unit price each, complete in place, including excavation and backfill.

The removal of unsuitable material below the required depth and the furnishing and placing of material in the voids thus created will be paid for in accordance with the provisions of Subsection 104.02 of the specifications.

SECTION 505 MANHOLES:

505-1 Description:

The work under this section shall consist of furnishing all materials and constructing complete manholes including frames and covers; furnishing and installing manhole frames and covers; or removing and resetting existing manhole frames and covers at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

505-2 Materials:

505-2.01 Concrete:

Materials furnished for Portland cement concrete shall conform to the requirements of Section 1006 of the specifications for Class B concrete, except precast manholes. Precast manholes shall conform to the requirements of AASHTO M 199 except that the compressive strength of

each unit will be determined and accepted in accordance with Subsection 1006-7 of the specifications.

505-2.02 Reinforcing Steel:

Materials furnished for reinforcing steel shall conform to the requirements of Section 1003 of the specifications.

505-2.03 Brick:

Brick shall conform to the requirements of AASHTO M 91.

505-2.04 Mortar:

Mortar shall conform to the requirements of Subsection 503-2.03 of the specifications.

505-2.05 Frames and Covers:

Frames and covers shall conform to the requirements of Subsection 1004-6 of the specifications for drainage structure castings. The bearing face of the frame shall be machined so that the cover will lie flat in any position in the ring and have a uniform bearing throughout its entire circumference. Before leaving the foundry, the frames and covers shall be thoroughly cleaned.

At the option of the manufacturer, manhole covers may be supplied from the foundry with the ADOT logo embossed in the center, at no additional cost to the Department. The current ADOT logo design at the time of cover installation shall be used. Manhole covers with out-dated logo designs will not be accepted for installation or payment.

505-3 Construction Requirements:

505-3.01 Manhole:

Excavation and backfill for the manhole shall be performed in accordance with the requirements of Subsection 203-5 of the specifications.

All connections for lateral pipes will be considered a part of the manhole. The invert channel may be lined with split pipe.

Manhole side-walls shall be constructed of cast-in-place or precast concrete, or brick, as shown on the project plans. The base of all manholes shall be cast-in-place concrete.

A list of approved precast units will be found in the Special Provisions.

Cast-in-place concrete shall be placed in accordance with the requirements of Section 601 of the specifications.

Bricks for side-walls shall be wetted before being used and shall be laid in full mortar beds. Mortar that has been mixed for more than one hour shall not be used. Re-tempering of mortar will not be permitted.

Proper equipment shall be provided for lowering the precast sections to position. The tongue end of the section shall be placed in contact with the base structure unless otherwise directed. Not more than two holes shall be cast or drilled in the shell of each section for the purpose of handling and placing. If such holes are provided, they shall be filled and finished with mortar after placing. Any precast section damaged during handling or placing shall be repaired or replaced at the option of the Engineer and at no additional cost to the Department.

Joints for precast concrete manhole sections shall be made with Portland cement mortar, rubber gaskets, mastic joint fillers, or by a combination of these types, or other approved type. The completed mortar joint shall be formed with a bead on the outside and finished smooth on the inside of the sections and suitably cured. The rubber ring gaskets shall be installed so as to form a flexible watertight seal. The mastic joint filler shall conform to the requirements of AASHTO M 198 and shall be applied in accordance with the manufacturers recommendations so as to form a watertight seal.

Where frames and covers for new manholes are to be set in new bituminous mix or asphaltic concrete surfaces, they shall not be set until the roadway has been surfaced. Where a bituminous seal coat or asphaltic concrete finishing course is to be placed on the new surfacing, the frames and covers shall be set after the surface course has been completed and prior to the placement of the seal coat or the finishing course.

Steel plates of a size approved by the Engineer shall be placed over the manhole prior to surfacing operations. After surfacing operations are completed, the steel plates shall be removed and the frames and covers set in concrete at the proper elevation so that the cover will be flush with the adjacent finished surface. Care shall be taken that the base and surfacing materials are not disturbed beyond the edges of the plate. Concrete and reinforcing steel shall be placed around the frame as detailed on the plans. The concrete shall be protected during the curing period.

Upon completion each manhole shall be thoroughly cleaned and kept clean until final acceptance of the work.

The contractor shall observe all the ordinances of the city or town in which the work is located. Streets shall be kept open for passage of traffic and protection for the public shall be provided when the manhole excavation is exposed and dangerous. The manhole construction work shall be completely and adequately covered when no work is being done.

Every precaution shall be taken to prevent water pumped from manholes from flooding streets, alleys, sidewalks, and private property.

505-3.02 Frame and Cover for Manhole:

Where an existing frame and cover for a manhole is unfit for further use, a new frame and cover shall be furnished and installed as specified under Subsection 505-3.01 of the specifications. Where necessary, existing side-walls shall be adjusted to the required grade by removing portions of, or adding to, the existing walls. Such adjustments shall conform to the details of the existing manhole unless otherwise detailed on the project plans.

505-3.03 Reset Manhole Frame and Cover:

Existing frames and covers to be reset shall be carefully removed and reset to the required grade in accordance with the requirements of Subsection 505-3.02 of the specifications; however, at the contractor's option and with approval of the Engineer, adjustable extension rings of the type which do not require the removal of the existing frame may be used. The extension device shall provide positive locking action with the existing frame and shall permit adjustment in height to conform to the new finish pavement surface. The material for the extension device shall be compatible with the existing frame and conform to the requirements of Section 1004 of the specifications.

Manhole frames and covers to be reset which are lost or damaged by the contractor's operations shall be replaced at no additional cost to the Department.

505-4 Method of Measurement:

Manholes will be measured as a unit for each manhole, including frame and cover; for each frame and cover; or for each existing frame and cover removed and reset.

505-5 Basis of Payment:

The accepted quantities of manholes, frame and cover for manhole, and reset manhole frame and cover, measured as provided above, will be paid for at the contract unit price each, complete in place, including excavation and backfill.

The removal of unsuitable material below the required depth and the furnishing and placing of material in the voids thus created will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

SECTION 506 UNDERDRAINS:

506-1 Description:

The work under this section shall consist of furnishing all labor, equipment, and materials to construct an underdrain system in accordance with the details shown on the project plans and as directed by the Engineer.

When more than one type of pipe is allowed to be installed at underdrain installations, the underdrain will be designated as alternative pipe underdrain on the plans and in the bidding schedule. The type of pipe to be installed shall be selected by the contractor from the allowable types of pipe shown on the plans.

506-2 Materials:

506-2.01 Pipe Materials:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for all pipe materials.

(A) Perforated Clay Pipe:

Perforated clay pipe shall conform to the requirements for extra-strength perforated clay pipe as specified in AASHTO M 65, except that plain end pipe complying in all other respects with the stated AASHTO M 65 specification may be used.

Design modifications to the bell socket end of the pipe which will facilitate positioning of the perforations or placement of the pipe may be made, provided that such modifications are approved by the Engineer prior to use. Pipe so modified shall conform to all performance requirements and tests specified in AASHTO M 65.

If plain end pipe is used, couplers which are capable of holding the pipe in alignment shall be used to join the pipe.

(B) Perforated Steel Pipe:

Perforated steel pipe and coupling bands shall conform to the requirements of AASHTO M 36 and M 218, with the following modifications: The pipe shall conform to any one of the full-circle types specified in AASHTO M 36, and perforations in the pipe shall be either drilled or punched. The perforations shall be located either in the inside crests or in the flat tangent portion of all corrugations, but not in both locations in a given length of pipe.

(C) Perforated Aluminum Pipe:

Aluminum underdrain pipe and fittings shall conform to the requirements of AASHTO M 196 with the following modifications: The pipe shall conform to Type III pipe according to AASHTO M 196. Perforations in the pipe shall be either drilled or punched. The minimum thickness of sheet shall be 0.06 inches.

(D) Perforated Plastic Pipe:

Perforated plastic pipe shall be either smooth-wall polyvinyl chloride plastic pipe, corrugated polyvinyl chloride plastic pipe with a smooth interior surface, or corrugated polyethylene plastic tubing.

Smooth-wall polyvinyl chloride plastic pipe shall conform to the requirements of AASHTO M 278.

Corrugated polyvinyl chloride plastic pipe with a smooth interior surface shall conform to the material and structural requirements of AASHTO M 278. The pipe shall have perforations located in the bottom half of the pipe and the perforations shall consist of slots meeting the size and opening area requirements listed in AASHTO M 252. The inside diameter and diameter tolerances shall conform to the requirements of either AASHTO M 252 or M 278.

Corrugated polyethylene plastic tubing shall conform to the requirements of AASHTO M 252 or M 294.

Polyvinyl chloride pipe shall be connected with belled ends, or with sleeve-type or stop-type couplings conforming to the requirements of AASHTO M 278. Polyethylene tubing shall be connected with snap-on, screw-on, or wrap-around fittings and couplings conforming to the requirements of AASHTO M 252 or M 294. Solvent cementing of joints will not be required.

506-2.02 Underdrain Outlets and Risers:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for all underdrain outlet and riser materials.

Underdrain outlets and underdrain terminal risers, vertical risers, and 45-degree risers, consisting of covers, pipes, band couplers, pipe elbows, tees, and wyes shall be furnished and installed in accordance with the details shown on the plans and as specified in these specifications.

Underdrain outlets and risers shall be fabricated of the same material as the underdrain pipe or of corrugated metal pipe. Except for covers and coupling band fastening hardware, aluminum and steel shall not be mixed in any installation. Outlet and riser pipe and fittings shall not be perforated.

The welded metal cover for risers shall conform to the details shown on the plans. Welded steel covers shall be galvanized after fabrication, in accordance with the provision in Subsection 604-3.05 of the specifications, Galvanizing.

Welding shall be in accordance with the requirements in Subsection 604-3.06 of the specifications, Welding.

Covers shall be fitted and bolted into the riser pipe or elbow. The covers shall seat uniformly and shall not be subject to rocking.

506-2.03 Drain Aggregate:

The drain aggregate shall conform to the following gradation when tested in accordance with the requirements of AASHTO T 11 and AASHTO T 27.

Sieve Size	Percent Passing
1-1/2 inch	100
1 inch	95 - 100
1/2 inch	25 - 60
No. 4	0 - 10
No. 8	0 - 5
No. 10	0 - 2

For underdrains within the roadway prism, the percent of fractured coarse aggregate particles for material retained on the No. 4 sieve shall be at least 90 when tested in accordance with the requirements of AASHTO T 335, unless otherwise approved by the Engineer.

The combined bulk specific gravity range for the aggregate shall be 2.35 to 2.85.

The combined water absorption range for the aggregate shall be 0 to 2.5.

Resistance to abrasion for aggregate will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

(A) Maximum loss of 9 percent at 100 revolutions; and

(B) Maximum loss of 40 percent at 500 revolutions.

506-2.04 Drainage Geotextile Fabric:

The drainage geotextile fabric shall be as specified in Subsection 1014-9 of the specifications.

506-3 Construction Requirements:

506-3.01 General:

The trench for the underdrain shall be excavated to the lines and grades shown on the project plans. The bottom of the trench shall be shaped in accordance with the details shown on the plans and prepared to provide full, firm and uniform support for the drainage geotextile fabric, aggregate, and perforated pipe.

506-3.02 Weather Limitations:

Drainage fabric placement and underdrain installation shall not be done when weather conditions, in the opinion of the Engineer, are not suitable to allow placement or installation.

Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

506-3.03 Fabric Placement:

Surfaces to receive drainage fabric, immediately prior to placing, shall be free of loose or extraneous material and sharp objects that may damage the fabric during installation. The fabric shall be aligned and placed in a wrinkle-free manner. Successive sheets or rolls of fabric shall be overlapped a minimum of 12 inches in the direction of water flow. The drain aggregate shall also be placed in the trench in the direction of water flow, if possible. Should the fabric be damaged during placing, the torn or punctured section shall be either completely replaced or shall be repaired by placing a piece of fabric that is large enough to cover the damaged area and to meet the overlap requirement. Damage to the fabric resulting from the contractor's vehicles, equipment or operations shall be replaced or repaired by the contractor at no additional cost to the Department.

506-3.04 Underdrain Construction Details:

Aggregate materials shall be placed with great care in a manner which does not damage the fabric. Pins or piles of aggregate can be used to hold the drainage fabric in place while aggregate is being placed. Aggregate materials shall be compacted in 6-inch maximum lifts with a minimum of three passes of a vibratory plate type compactor.

Perforated pipes shall be laid with the perforations down.

Outlets, riser pipes, and associated fittings shall be constructed in accordance with the details shown on the plans and specifications and as directed by the Engineer.

The outlet for each underdrain shall be clean at the time of installation and shall be free of obstructions after installation. Pipes that are found to be plugged shall be replaced by the contractor, including replacement

of aggregate materials, surfacing and backfill materials, at no additional cost to the Department.

After placing the drain aggregate, the geotextile drainage fabric shall be folded over the top of the drain aggregate to produce a minimum overlap of 12 inches for trenches greater than 12 inches wide. In trenches less than 12 inches in width, the overlap shall be equal to the width of the trench. The geotextile drainage fabric shall then be covered with the subsequent course.

506-4 Method of Measurement:

Underdrains will be measured by the linear foot along the centerline of the pipe. Measurement will be made end-to-end to the nearest foot along the actual length of pipe. The pay length shall not exceed the length staked or ordered by the Engineer.

Elbows, wyes, tees, risers, outlets, and other branches will be measured by the linear foot for the size and type of underdrain pipe they are connected to. Elbows, outlets and risers will be measured along centerline. Wyes, tees, and other branches will be measured along centerlines to the point of intersection.

The total linear feet measured of each type and size of underdrain pipe shall be the sum of the above measured quantities.

506-5 Basis of Payment:

The accepted quantities of each type and size of underdrain measured as provided above, will be paid for at the contract unit price per linear foot, complete in place. The contract price shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals involved in installing perforated pipe, drainage fabric, and aggregate material as specified in the plans and specifications, and as directed by the Engineer. The contract unit price shall also include connecting outlets to drainage facilities, welded metal covers, and any necessary excavation and backfill.

SECTION 507 EDGE DRAINS:

507-1 Description:

The work under this Section shall consist of furnishing all labor, equipment, and materials to construct an edge drain system in accordance with the details shown on the project plans and as directed by the Engineer. The edge drain system shall include installation of plastic pipe edge drains and edge drain outlets, vents, and cleanouts, and furnishing and placing permeable drain material, filter fabric, and miscellaneous appurtenances as shown on the plans and as specified in these specifications and Special Provisions.

507-2 Materials:

507-2.01 Pipe Materials:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for all pipe material.

Pipe and pipe fittings for edge drains and edge drain outlets, vents, and cleanouts shall be of the size shown on the project plans.

Pipe installed in trenches to be backfilled with asphalt-treated permeable material shall be polyvinyl chloride (PVC) 90 degrees C electric plastic conduit, EPC-40 or EPC-80, conforming to the requirements of NEMA Specification TC-2.

All pipe for edge drains and edge drain outlets, vents, and cleanouts shall, at the contractor's option, conform to one of the following:

(A) PVC 90 degrees C electric plastic conduit, EPC-40 or EPC-80, conforming to the requirements of NEMA Specification TC-2; or

(B) PVC plastic pipe, Schedule 40 or Schedule 80, conforming to the requirements of ASTM D1785. The type, grade, and design stress designation of the pipe shall be either 1120, 1220, 2120, 2116, 2112, or 2110 as specified in ASTM D1785.

Pipe shall be straight-end or bell-end. Bell and sockets shall conform to the requirements of ASTM D2672 except for the marking.

In addition, pipe designated as slotted on the plans shall have three rows of slots in the pipe. The rows shall be in the longitudinal direction of the pipe and the slots shall be cut in the circumferential direction of the pipe. The three rows shall be spaced equally around the circumference of the pipe. Each row shall have 22 ± one uniformly spaced slots per linear foot of pipe. The slots shall be 0.045 to 0.065 inches wide and of such length as to provide a minimum of 2.00 square inches of slot opening per linear foot of pipe. Other suitable configurations of slots which provide drainage equal to or better than the above slot requirements may be used if approved in writing by the Engineer.

Except as otherwise provided for wye fittings, fittings for PVC 90 degrees C electric plastic conduit shall conform to the requirements of NEMA Specification TC-3, and the fittings for PVC plastic pipe shall be socket-type fittings conforming to ASTM D2467 for Schedule 80 pipe and ASTM D2466 for Schedule 40 pipe. Wye fittings shall be shop fabricated from pipe conforming to the requirements for the type of edge drain pipe installed. The fitting shall provide an unobstructed passageway through both legs of the wye.

507-2.02 Treated Permeable Material:

Permeable material for edge drains shall be asphalt treated permeable material or cement treated permeable material. The type of treatment (asphalt or cement) for the permeable material shall be at the contractor's option.

Treated permeable material shall be stored, proportioned, and mixed in accordance with the requirements of these specifications.

(A) Asphalt Treated Permeable Material:

Aggregates shall be clean and free from decomposed materials, organic material, and other deleterious substances.

The gradation of the aggregate shall meet the following requirements when tested in accordance with AASHTO T 11 and AASHTO T 27:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	90 - 100
1/2 inch	35 - 65
3/8 inch	20 - 45
No. 4	0 - 10
No. 8	0 - 5
No. 200	0 - 2.0

Aggregate shall conform to the following quality requirements prior to the addition of asphalt:

Tests	Test Method	Requirement
Fractured Coarse Aggregate Particles	AASHTO T 335	Min. 90%
Abrasion	AASHTO T 96	500 Rev., Max. 45%
Sand Equivalent	AASHTO T 176	Min. 55

The combined bulk specific gravity range for the aggregate shall be 2.35 to 2.85.

The combined water absorption range for the aggregate shall be zero to 2.5.

Asphalt to be mixed with the aggregate shall be PG 64-16 unless otherwise specified or approved by the Engineer.

Aggregates and asphalt for asphalt treated permeable material shall be stockpiled, proportioned, and mixed in the same manner provided for in Subsection 406-6 of the specifications, except as follows:

The aggregate need not be separated into sizes. The temperature of the aggregate before adding the asphalt binder shall not be less than 275 degrees F nor more than 325 degrees F. Asphalt treated permeable material stored in excess of two hours shall not be used in the work. The aggregate shall be combined with 2.5 percent paving asphalt by weight of the dry aggregate. After testing samples of the contractor's proposed aggregate supply, the Engineer may order an increase or decrease in the target asphalt content. If such increase or decrease is ordered, and the increase or decrease shall be less than 0.5 percent by weight of the dry aggregate, no additional compensation for this increase or decrease of asphalt content will be payable to the contractor for the asphalt treated permeable material. Once the target asphalt content is determined, the asphalt cement content will be accepted in accordance with Subsection 406-7.04 of the specifications.

(B) Cement Treated Permeable Material:

Aggregates shall be clean and free from decomposed materials, organic material, and other deleterious substances. All-natural aggregates shall be thoroughly and uniformly washed before use.

The gradation of the aggregate shall meet the following requirements when tested in accordance with AASHTO T 11 and AASHTO T 27:

Sieve Size	Percent Passing
1-1/2 inch	100
1 inch	88 - 100
3/4 inch	50 - 80
3/8 inch	15 - 40
No. 4	0 - 16
No. 8	0 - 6
No. 200	0 - 2.0

Aggregate shall conform to the following additional quality requirements prior to the addition of cement:

Tests	Test Method	Requirement
Fractured Coarse Aggregate Particles	AASHTO T 335	Min. 90%
Abrasion	AASHTO T 96	500 Rev., Max. 45%
Sand Equivalent	AASHTO T 176	Min. 55

The combined bulk specific gravity range for the aggregate shall be 2.35 to 2.85.

The combined water absorption range for the aggregate shall be zero to 2.5.

Aggregates and cement for cement treated permeable material shall be stockpiled, proportioned, and mixed in the same manner provided for in Subsection 1006-4 of the specifications, except as follows:

Dividing of the aggregate into sizes will not be required. The Portland cement content of cement treated permeable material shall be no less than 282 pounds per cubic yard. The water:cement ratio (the ratio of the amount of water, exclusive only of that absorbed by the aggregate, to the amount of cement, by weight) shall be approximately 0.37:1. The exact water:cement ratio shall be as specified or approved by the Engineer.

(C) Drainage Geotextile Fabric:

The drainage geotextile fabric shall be as specified in Subsection 1014-9 of the specifications.

(D) Miscellaneous Materials:

Concrete for splash pads shall conform to the requirements of Class B concrete.

Mortar placed where edge drain outlets and vents connect to drainage pipes and existing drainage inlets shall be composed of Portland cement, fine aggregate, and water proportioned and mixed as specified herein.

The proportion of cement to fine aggregate, measured by volume, shall be 1:2, unless otherwise specified.

All materials used in the mortar shall conform to the requirements listed in Subsection 1006-2 of the specifications.

The mortar shall contain only enough water to permit placing and packing.

Concrete areas in contact with the mortar shall be cleaned of all loose or foreign material that would in any way prevent bond between the mortar and the concrete surfaces and shall be flushed with water and allowed to dry to a surface dry condition immediately prior to placing the mortar.

The mortar shall completely fill and shall be tightly packed into recesses and holes, on surfaces, under structural members, and at other locations as specified. After placing, all surfaces of mortar shall be cured by the water method as provided for in Subsection 1006-6.01(B) of the specifications for a period not less than three days.

All improperly cured or otherwise defective mortar shall be removed and replaced by the contractor at no additional cost to the Department.

Expansion type pressure plugs for cleanouts shall seat firmly against the lip of the pipe and shall be an expandable plug manufactured from neoprene or commercial quality expandable duct plugs. The expandable

plug shall consist of reinforced polypropylene rigid threaded plug with a commercial quality thermoplastic rubber sealing ring.

507-3 Construction Requirements:

507-3.01 General:

Edge drains, edge drain outlets, vents, cleanouts, treated permeable material, and filter fabric shall be installed in accordance with the details shown on the plans and as specified herein unless otherwise approved by the Engineer.

Prior to excavating trenches in existing paved areas, the outline of the paved areas to be removed shall be cut to a neat line to a minimum depth of 2 inches with a power-driven saw or a wheel type rock cutting excavator. Cuts along the joint between existing asphalt concrete and existing Portland cement concrete pavement will not be required.

507-3.02 Weather Limitations:

Drainage fabric placement and edge drain installation shall not be done when weather conditions, in the opinion of the Engineer, are not suitable to allow placement or installation.

Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

507-3.03 Fabric Placement:

Surfaces to receive drainage fabric shall, immediately prior to placing, be free of loose or extraneous material and sharp objects that may damage the fabric during installation. The fabric shall be aligned and placed in a wrinkle-free manner. Successive sheets or rolls of fabric shall be overlapped a minimum of 12 inches in the direction the material is being spread. Should the fabric be damaged during placing, the torn or punctured section shall be either completely replaced or shall be repaired by placing a piece of fabric that is large enough to cover the damaged area and to meet the overlap requirement. Damage to the fabric resulting from the contractor's vehicles, equipment, or operations shall be replaced or repaired by the contractor at no additional cost to the Department.

507-3.04 Edge Drain Construction Details:

Pipe and fittings shall be joined by solvent cementing. The solvent cement and primer shall be of commercial quality specifically manufactured for use with rigid PVC plastic pipe and fittings. The solvent cement and primer used shall be made by the same manufacturer. The color of the primer shall contrast with the color of the pipe and fittings. The solvent cement and primer shall be used in accordance with the manufacturer's printed instructions.

Treated permeable material shall be spread only when the atmospheric temperature is above 40 degrees F and in layers not to exceed 8 inches.

When edge drains are to be installed adjacent to an asphalt treated permeable base, the treated permeable material may be spread with the treated permeable base, except for the lower 6 inches of asphalt treated permeable material, which shall be spread in a separate operation.

Asphalt treated permeable material shall be placed at a temperature of not less than 180 degrees F nor more than 230 degrees F. When asphalt treated permeable material is spread with asphalt treated permeable base, the placement shall conform to the temperature requirements for spreading asphalt treated permeable base.

Treated permeable material spread with adjacent treated permeable base shall be compacted in the same manner as specified for compacting the base. All other layers of treated permeable material shall be compacted with a vibrating shoe-type compactor connected to a spreading device. The vibrating shoe-type compactor shall be in operation only when the material is being spread in the trench.

Cement treated permeable material which is not covered with asphaltic concrete within 12 hours after compaction of the permeable material shall be cured by either sprinkling the material with a fine spray of water every four hours during daylight hours or covering the material with a white polyethylene sheet, not less than 6 mils thick. The above curing requirements shall begin at 7:00 a.m. on the morning following compaction of the cement treated permeable material and continue for the next 72 hours or until the material is covered with asphaltic concrete, whichever is less. The cement treated permeable material shall not be sprayed with water during the first 12 hours after compacting, but shall be covered with the polyethylene sheet from the completion of the compaction to the beginning of the cure period.

Trenches in the existing embankment areas shall be backfilled with native material and compacted as directed by the Engineer.

Aggregate base for backfilling trenches in existing paved areas shall be Class 1, 2, or 3 aggregate base. Aggregate base backfill shall be spread and compacted by methods that will produce a uniform base, firmly compacted, and free from pockets of coarse or fine material.

Asphaltic concrete for backfilling trenches in existed paved areas shall be dense graded asphaltic concrete material as approved by the Engineer. Prior to placing the asphaltic concrete backfill, a tack coat of asphaltic emulsion shall be applied to the vertical edges of existing pavement at an approximate rate of 0.05 gallons per square yard. Asphaltic concrete backfill shall be spread and compacted in approximately two equal layers by methods that will produce an asphaltic concrete surfacing of uniform smoothness, texture, and density. Each layer shall be compacted before the temperature of the mixture drops below 250 degrees F.

Surplus excavated materials shall become the property of the contractor and shall be disposed of in accordance with the specifications outside the right of way.

The locations of outlets, vents, and cleanouts will be marked with soil anchored flexible delineator posts in accordance with the plans and as approved by the Engineer.

The edge drain outlet, vent, and cleanout pipes shall be clean at the time of installation and shall be free of obstructions after installation. The contractor shall use a high pressure, flexible hose with a nominal 1-inch diameter nozzle containing flushing and propelling jets. The hose shall be inserted into each edge drain outlet, vent, and cleanout pipe and pushed through the pipe with a minimum 1,000 pounds per square inch water pressure so that the entire edge drain system will be penetrated by the flushing nozzle. Pipes that are found to be plugged shall be replaced by the contractor, including replacement of treated permeable material, surfacing and backfill materials, at no additional cost to the Department.

Outlet and vent covers consisting of commercial quality 1/2-inch mesh galvanized metal screens or grates with polyvinyl chloride slip joint nut fittings shall be installed at the end of each outlet pipe and vent pipe.

507-4 Method of Measurement:

The various sizes of edge drains, drain outlets, splash blocks, vents, and cleanouts, as shown on the plans, will be measured by the linear foot along the centerline of the pipe and shall include the length of fittings. Tees, wyes and other branches will be measured as pipe along the central axis of the pipes to the point of intersection. Measurement will be made end to end to the nearest foot along the actual length of pipe. The pay length shall not exceed the length staked or ordered by the Engineer.

The total linear feet measured of each type and size of underdrain pipe shall be the sum of the above measured quantities.

507-5 Basis of Payment:

The accepted quantities of each type and size of edge drain measured as provided above, will be paid for at the contract unit price per linear foot, complete in place. The contract price shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals involved in installing perforated pipe, drainage fabric, and treated permeable material as specified in the plans and specifications, and as directed by the Engineer.

This contract unit price shall also include outlet and vent covers, expansion plugs, flexible markers for future location, concrete splash pads, connecting outlets and vents to drainage facilities, and any

necessary excavation and backfill of aggregate base, asphaltic concrete, asphalt emulsion tack coat, and native materials.

No deduction in the length of plastic pipe will be made for gaps in edge drain pipe at locations of dual outlet, dual vent, or dual outlet and vent connections to the edge drain.

SECTION 601 CONCRETE STRUCTURES:

601-1 Description:

The work under this section shall consist of furnishing all materials and constructing structures or parts of structures to the forms, shapes, and dimensions shown on the project plans and to the lines and grades established by the Engineer and in accordance with the requirements of the specifications. When the structures or parts of structures are precast, the work shall also include transporting and erecting the units.

Precast/Prestressed concrete structural bridge members such as, but not limited to I-Beams and Box Beams are hereby defined as precast bridge structures. Precast bridge structures shall be constructed per the project plans and the requirements of these specifications.

Concrete structures such as manhole, concrete pipe, cattle guards, catch basins, median barriers, headwalls, and other small miscellaneous structures of sizes which can readily be precast as units and furnished and installed in place are hereby defined as minor precast structures. Minor precast structures, at the option of the contractor, may be either constructed of cast-in-place concrete or furnished and installed as precast units providing they are fabricated in accordance with drawings submitted and approved in accordance with the requirements of the specifications.

References to “precast concrete items” shall be understood to include both precast bridge structures and minor precast structures.

Minor precast structures shown on the Department’s Approved Products List (APL) may be used as alternatives to cast-in-place minor structures. The current list of such precast structures is available on the internet from the Arizona Department of Transportation Research Center through its product evaluation program. Minor precast structures not appearing on the APL may be considered for use in accordance with the requirements of Subsection 106.14 of the specifications.

The "H" dimension for catch basins shall be determined in the field prior to casting. The contractor shall be familiar with conditions peculiar to the project, which might limit the use of precast items.

The use of precast cattle guards for either H-10 or H-20 loading shall be limited to roadway locations with maximum longitudinal grades of 6 percent.

601-2 Materials:

601-2.01 General:

A Certificate of Compliance or a Certificate of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be

submitted for all specified and applicable materials subject to shop drawing approval prior to their incorporation into precast concrete items. Materials include, but are not limited to; reinforcing steel, prestressed cable strands, bearing plates, embed materials, inserts, anchor plates, epoxy coated or galvanized materials, and mechanical lifting devices. Materials that fail to have the required certification will not be allowed.

A Certificate of Compliance conforming to the requirements of Subsection 106.05 of the specifications for concrete pipe shall accompany each delivery, and shall include the class or type, quantity, and the approved dates of the concrete pipe delivered.

Portland cement concrete shall conform to the requirements of Section 1006 of the specifications for Class S or Class B concrete as shown on the project plans.

When the specified concrete strength is shown on the project plans but a class of concrete is not indicated, it shall be construed to mean Class S concrete having the required minimum compressive strength shown at 28 days.

Except for tack welding of steel cages for concrete pipe and manholes, all welding for precast concrete items shall be performed by or under the supervision and direction of a welder certified for the type of welding required; however, all structural welding and precast bridge structure welding, such as studs, bearing plates, etc. shall be performed by a welder certified for the type of welding specified. Reinforcing steel cages welded by automated equipment or by plant personnel shall be tested by the manufacturer quarterly, at random, for strength. When requested, reinforcement weld test results shall be supplied to the Engineer. The manufacturer shall submit welding certifications to the Engineer before welding operations begin.

Liquid membrane-forming compound shall conform to the requirements of Subsection 1006-6.01(C) of the specifications.

Materials furnished for expansion joint filler and joint seal shall conform to the requirements of Section 1011 of the specifications.

Materials furnished for water stops shall conform to the requirements of Section 1011 of the specifications.

Preformed bearing pads and elastomeric bearing pads shall conform to the requirements of Section 1013 of the specifications.

Reinforcing steel shall conform to the requirements of Section 1003 of the specifications.

For cast-in place concrete used in bridge deck placement, fiber additives shall be incorporated into the concrete mix for plastic shrinkage control. Fiber additive shall be Polyolefin, conforming to the requirements of

ASTM D7508/D7508M and applicable requirements of Section 1006 of the specifications. The specific type, size, and quantity of fiber additive shall be determined by the mix designer. The contractor shall submit the results from ASTM C1579, along with the proposed concrete mix design, to the Engineer for review and approval. Fiber additive shall be composed of 100 percent virgin materials and shall be non-corrosive, non-magnetic, and entirely alkali-free.

601-3 Construction Requirements:

601-3.01 General:

(A) Shop Drawings:

Shop drawings of the proposed concrete structures shall be submitted in accordance with the requirements of Subsection 105.03 of the specifications.

The size, shapes, dimensions, and concrete cover shall be shown for the reinforcing steel, including any reinforcing steel to be relocated or added.

In addition to all required working drawings, the contractor shall prepare composite drawings in plan, elevation and section which show to scale the relative positions of all items that are to be embedded in the concrete. Such embedded items include the reinforcing steel, anchor bolts, earthquake restrainers, deck joint assemblies, drainage systems, utility conduits and other such items. Such drawings shall be adequate to ensure that there will be no conflict between the planned positions of any embedded items, and that concrete cover will be adequate. If during the preparation of such drawings conflicts are discovered, the contractor shall revise its working drawing for one or more of the embedded items, or propose changes in the dimensions of the work as necessary to eliminate the conflicts or provide proper cover. Any such revisions shall be approved by the Engineer before work on an effected item is started.

The shop drawings reviewer shall notate their full first and last name and contact phone number on the approved shop drawings. The contractor shall submit a copy of the approved shop drawings to the Structural Materials Testing Section at least 5 working days in advance of the start of production of the precast items. Any changes to shop drawings must be approved by the Engineer. These updated and approved shop drawings shall be sent to the Structural Materials Testing Section at least 24 hours in advance of the start of production.

(B) Scheduling and Inspection of Precast Items:

The contractor shall provide the Engineer written notification a minimum of 10 days prior to start of production. The contractor shall also provide notification for any changes in production or pauses in production of precast items that require detailed inspections.

The contractor shall schedule a meeting which includes the precast manufacturer's QC Manager and Production Manager, the Engineer, and Structural Materials Testing Section personnel to discuss scheduling and potential issues regarding the precast items to be manufactured. The meeting shall be held no less than 7 days prior to the start of production.

The contractor shall provide the Engineer on the Friday before any subsequent week of production a written schedule for the upcoming seven days which includes the following:

(1) Date and time for the start of production;

(2) Scheduled times for tensioning (if applicable);

(3) Scheduled times for steel inspection;

(4) Pour schedule including product ID or marked number for casting; and

(5) Scheduled times for concrete release breaks.

The contractor shall provide a written notice to the Engineer a minimum of 10 days prior to delivery of precast items in order for the Structural Materials Testing Section to schedule and perform a final inspection.

601-3.02 Falsework and Forms:

(A) Design and Drawings:

The contractor shall be responsible for designing and constructing safe and adequate falsework and forms which provide the necessary rigidity, support the loads imposed, and produce in the finished structure the lines, grades, and dimensions shown on the project plans and established by the Engineer.

The contractor shall apply the best practice principles available from the current publications of AASHTO's Guide Design Specifications for Bridge Temporary Works and Construction Handbook for Bridge Temporary Works.

Forms shall be any system of structural elements which provide horizontal support or restraint to the lateral pressure of concrete.

Falsework shall be any system of structural elements that provide temporary lateral and vertical support for loads from plastic concrete, forms, reinforcing steel, structural steel, loads from placement operations or other related loads, and continues to provide support until the concrete has attained adequate strength and the structure is capable

of self-support. Stay-in-place metal forms for cast-in-place concrete decks are also considered a falsework system.

The design load for falsework shall consist of the sum of dead and live vertical loads, and an assumed horizontal load. The minimum total vertical design load for any falsework shall be not less than 100 pounds per square foot for the combined live and dead load, applied over the area supported, regardless of concrete slab thickness.

Dead loads shall include the weight of concrete, reinforcing steel, forms, and falsework. The weight of concrete, reinforcing steel and forms shall be assumed to be not less than 160 pounds per cubic foot for normal concrete and not less than 130 pounds per cubic foot for lightweight concrete.

Live loads shall consist of the actual weight of any equipment to be supported by falsework applied as concentrated loads at the points of contact and a uniform load of not less than 50 pounds per square foot applied over the area supported.

The assumed horizontal load to be resisted by the falsework bracing system shall be the sum of the actual horizontal loads due to equipment, construction sequence or other causes and an allowance for wind, but in no case shall the assumed horizontal load to be resisted in any direction be less than 2 percent of the total dead load. The falsework shall be designed so that it has sufficient rigidity to resist the assumed horizontal load without considering the weight of the concrete.

If the concrete is to be prestressed, the falsework shall be designed to support any increased or readjusted loads caused by prestressing forces.

Falsework shall be designed by the working stress design method, and stresses under all loads shall not exceed the maximum allowable stresses provided for in the current edition of AASHTO Guide Design Specifications for Bridge Temporary Works. The maximum allowable stresses provided for in the current National Design Specification (NDS) for wood construction may be used as an alternate to the AASHTO specifications for timber design. The maximum allowable horizontal shear stress in timber shall not exceed 125 pounds per square inch after all applicable modification factors have been applied. No increase in allowable stresses for repetitive member uses will be allowed.

Unless otherwise specified on the plans, deflection of the falsework span due to the weight of concrete only shall not exceed 1/240 of the falsework beam span irrespective of the fact that the deflection may be compensated for by camber strips.

In the case of post-tensioned structures, the falsework deflections shall not produce stresses in the structure at any time prior to post-tensioning

greater than 0.8 times the modulus of rupture for plain concrete unless approved by the Engineer.

Falsework over or adjacent to roadways or railroads which are open to traffic shall be designed and constructed so that the falsework is stable if subjected to impact by vehicles. Falsework posts which support members that cross over a roadway or railroad shall be considered as adjacent to roadways or railroads. Other falsework posts shall be considered as adjacent to roadways or railroads only if they are located in the row of falsework posts nearest to the roadway or railroad and the horizontal distance from the traffic side of the falsework to the edge of pavement or to a point 10 feet from the centerline of track is less than the total height of the falsework and forms.

The vertical load used for the design of falsework posts and towers, but not footings, which support the portion of the falsework over openings, shall be increased to not less than 150 percent of the design load calculated in accordance with the provisions for design load previously specified.

Falsework posts adjacent to roadways or railroads shall consist of either steel with a minimum section modulus about each axis of 9.5 inches cubed or sound timbers with a minimum section modulus about each axis of 250 inches cubed.

Each falsework post adjacent to roadways or railroads shall be mechanically connected to its supporting footing at its base, or otherwise laterally restrained, so as to withstand a force of not less than 2,000 pounds applied at the base of the post in any direction except toward the roadway or railroad track. Such posts also shall be mechanically connected to the falsework cap or stringer. Such mechanical connection shall be capable of resisting a load in any horizontal direction of not less than 1,000 pounds.

For falsework spans over roadways, all exterior falsework stringers, stringers adjacent to the ends of discontinuous caps, the stringer or stringers over points of minimum vertical clearance, and every fifth remaining stringer, shall be mechanically connected to the falsework cap or framing. Such mechanical connections shall be capable of resisting a load in any direction, including uplift on the stringer, of not less than 500 pounds. Such connections shall be installed before traffic is allowed to pass beneath the span. For falsework spans over railroads, all falsework stringers shall be so connected to caps.

The falsework shall be located so that falsework footings or piles are at least 3 inches clear of railing posts and barriers and all other falsework members are at least 1 foot clear of railing members and barriers.

Falsework bents within 20 feet of the center line of a railroad track shall be sheathed solid in the area between 3 and 17 feet above the track elevation on the side facing the track. Sheathing shall consist of plywood not less than 5/8 inch thick or lumber not less than 1 inch thick

(nominal). Bracing on such bents shall be adequate so that the bent resists the required assumed horizontal force or 5,000 pounds, whichever is greater.

Drawings shall be prepared in accordance with the requirements of Subsection 105.03 of the specifications.

The drawings shall be complete and show the dimensions and material for all parts, arrangement, spacing, and connections, and all provisions for adjustment and for measuring displacement. The falsework foundations, any connections or contacts with previously built structures or other works, and the means of protecting such other works from damage shall be detailed. The above data may be presented either on the drawings or in the design summary, which shall also describe the assumptions and types of calculations used in the design and the stresses and deflections found for critical points.

For soffit fill construction, the equivalent of the above drawings and data shall be submitted, and in addition the source, classification, and compaction requirements for the material and the results of any tests performed on the material. In no case shall the soffit fill be compacted to less than 90 percent compaction, and the top 3 feet shall be compacted to a minimum of 95 percent compaction when tested in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. The soffit fill shall be topped with a lean concrete waste slab screeded to the required grades.

Falsework design requires written approval by the Engineer prior to commencing work and shall be in accordance with the requirements of Subsection 105.03 of the specifications. Falsework calculations shall be sealed and signed by a professional engineer who is registered as a Civil or Structural Engineer in the State of Arizona.

In the application and design of deck falsework systems, all bridge girders, new or existing, shall be braced or tied to resist any forces that would cause rotation and torsion in the girders caused by the placing of concrete for diaphragms or decks. The bracing system shall be included in the deck falsework design and shown on the deck falsework drawings. The contractor may choose not to provide a bracing system only when calculations demonstrate that the existing bridge components already provide adequate resistance to rotation and torsion. The calculations shall include this check and clearly show that the bridge girders can resist rotation and torsion without additional bracing.

Except as provided for on the project plans, supports for deck falsework, forming or screed supports shall not be welded to steel girders, shear connectors, slab ties, or girder stirrups.

Modifications of girders to support falsework and forming will not be allowed except as approved by the Engineer. This includes connections of any type in girder webs and flanges to support deck forming. Through-

holes of any type in girder flanges will not be permitted. When modification of girders to support the deck falsework and forming has been approved by the Engineer, shop drawings for both the girders and the falsework and forming shall be submitted concurrently so that the review and approval of the drawings can be coordinated.

The tops of the erected girders shall be surveyed by the contractor in the field prior to placement of the deck forming falsework. The survey shall include girder ends, tenth points, station and offset of survey point locations, or as specified in the project plans. This survey shall be submitted to the Engineer for evaluation. If the top of erected girder elevations are higher than the screed elevations minus the combined deck slab and the buildup thicknesses, adjustments may have to be made in the roadway profile, screed elevations, or girder bearing seat elevations. Encroachment into the deck slab of up to 1/2 inch will be allowed for random occurrences.

(B) Falsework Construction:

(1) General Requirements:

The falsework shall be constructed to conform to the falsework drawings. The materials used in the falsework construction shall be of the quality necessary to sustain the stresses required by the falsework design. The workmanship used in falsework construction shall be of such quality that the falsework supports the loads imposed.

The contractor shall provide temporary bracing for the falsework system to withstand all imposed loads during erection and removal of any falsework. Wind loads must be included in the design of the temporary bracing.

Falsework shall be founded on a solid footing safe against undermining and capable of supporting the loads imposed.

Wedges, screws, or jacks shall be used in connection with falsework to set the forms to required grade and uniform bearing prior to placing concrete.

All wedges shall be in pairs to ensure uniform bearing. Laminated sections will not be permitted. If additional material is required under wedges, either single blocks or thicker wedges will be required. A sufficient number of wedges shall be used to cover the entire bearing area.

The contractor shall provide tell-tales attached to the soffit forms and readable from the ground in enough systematically placed locations to determine the total settlement of the entire portion of the structure where concrete is placed.

If any signs of distress develop during the placing of the concrete or the falsework shows any undue settlement or distortion, the work shall be stopped and the falsework corrected and strengthened.

(2) Submittals:

The contractor shall submit to the Engineer the methods and sequences of falsework construction, including all equipment the contractor plans on using to erect the falsework, and shall certify that the material used to construct the falsework meets the requirements of Subsection 601-3.02(B)(1) of the specifications.

If the contractor elects to deviate from the superstructure placing diagram shown on the design plans, the contractor shall submit a superstructure placing diagram showing concrete placing sequence and construction joint locations per the requirements of Subsection 601-3.03(B) of the specifications.

No concrete shall be placed in any forms supported by falsework until the contractor's Professional Engineer or their designee has inspected the completed falsework, and the contractor's Professional Engineer has issued a properly sealed and signed certificate that the falsework has been constructed according to the approved falsework drawings.

(3) Material:

When timber members are used to brace falsework bents which are located adjacent to roadways or railroads, all connections for such timber bracing shall be of the bolted type using 5/8 inch diameter or larger bolts, or shall be connected in a manner that equals 100 percent capacity of the smaller member connected.

(4) Welding:

All field welds must be performed by an AWS certified welder. The contractor shall submit copies of current AWS certification for all welders to the Engineer before any field welding begins.

Field welding and inspection of field welding must comply with the requirements of the most recent edition of the ANSI/AWS Structural Welding Code - Steel.

(C) Forms Construction:

(1) General Requirements:

Forms shall be of wood, metal, or other suitable material conforming to the requirements specified herein. Forming plans for cast-in-place bridge girders shall be prepared in accordance with the requirements of Subsection 105.03 of the specifications.

The forms shall be mortar tight and shall be designed, constructed, braced and maintained so that the finished concrete is true to line and elevation and conforms to the required dimensions and contours. Forms shall be designed to withstand the pressure of concrete with consideration given to rate of concrete placement, temperature of the concrete, use of set-retarding admixtures or pozzolanic materials in the concrete, the effects of vibration as the concrete is being placed, and all loads incidental to the construction operations, without distortion, or displacement.

Stay-in-place forming shall not be used unless specified on the plans or approved by the Engineer. Expanded metal mesh may be used to form construction joints provided 3 inch cover is maintained. The use of expanded metal mesh in bridge decks is prohibited.

Forms to be reused shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity, mortar-tightness, and smoothness of surface. Forms or form lumber unsatisfactory in any respect shall not be used.

Forms shall be constructed so that portions may be removed without disturbing forms that are to remain. Forms to be used when a Class II finish or ornamental work is required shall be constructed of metal, fiberglass coated panels, or plywood. All form joints shall be taped or caulked. Forms for this work shall be equivalent to first class pattern work.

Forms shall be filleted 3/4 inch at all exposed, sharp corners of the concrete, unless otherwise noted in the plans.

All forms shall be treated with an approved form release agent before concrete is placed. Any material which would adhere to or discolor the concrete shall not be used.

Forms shall be cleaned of all dirt, sawdust, water, and other foreign material prior to placing concrete in the forms.

For narrow walls and columns where the bottom of the form is inaccessible, provisions shall be made for cleaning out extraneous material immediately before placing the concrete. The cells of box girders shall be cleared of all loose materials prior to the completion of deck forming when such forming is to remain in place. When the deck forming is to be removed, the cells of the box girders shall be cleared of all loose materials after removal of the forms.

(2) Wood Forms:

All lumber used for forms shall be free from defects affecting the accuracy of shape, strength, rigidity, mortar-tightness, and smoothness of the surface. All lumber for forms above stream beds shall be plywood. All form lumber shall be securely fastened to the studding so that

cupping cannot occur. Chamfer strips shall be of selected material dressed to true line and uniform dimensions. The interior surfaces of all forms in contact with concrete surfaces in the finished work shall be smooth and even. No uneven or offset joints or single boards projecting so that their impressions are left in the concrete will be allowed. Forms, as far as practicable, shall be so constructed that the form marks conform to the general lines of the structure. In general, grain of the lumber and direction of side joints shall be horizontal on wide faces and walls and vertical on narrow faces. If varying widths of panels are used, the wider panels shall be placed on the bottom and the narrower panels near the top. Panel end joints shall be staggered not less than 3 feet. Spreaders made of wood shall not be left in the concrete.

(3) Metal, Fiberglass, and Other Forms:

The same provisions as specified under wood forms shall apply to metal and fiberglass forms and in addition, the following shall apply:

(a) All bolts and rivet heads shall be countersunk. Clamps, rods, pins, or other connecting devices shall be designed to hold the forms rigidly together and allow removal without injury to the concrete. Forms which do not present a smooth surface or are not properly aligned shall not be used;

(b) Care shall be exercised to keep the forms free of dust, grease, or other foreign matter which discolors the concrete;

(c) Metal forms shall be used for the casting of precast I-beams, box beams, and voided or flat slabs where the contract number of units combined dictates production runs equal to or longer than the precasting bed length. A limited number of units, having a total combined length at least one unit length less than bed length, may be cast with alternate forms, as approved by the Engineer. Dimensional tolerances using alternate forms shall conform to the requirements of Subsection 601-4.02(B) of the specifications; and

(d) Waste slabs used as a part of the forms shall be finished to the appropriate grade including any camber. The finished slab shall not vary more than 1/4 inch from the theoretical grade nor more than 1/4 inch from a 10 foot straightedge in any direction.

(4) Internal Cells:

Internal cells or voids in pre-cast box beams shall be constructed with either wood forms conforming to Subsection 601-3.02(C)(2) of the specifications, or with solid expanded polystyrene.

When solid expanded polystyrene is used, the entire top surface of the polystyrene of the internal void shall be covered with 3/8-inch thick, exterior-grade plywood. Butt joints of the plywood sections shall be at least 2 feet away from any joined section of polystyrene. Polystyrene sections shall be securely held together by an adhesive recommended by the manufacturer of the polystyrene.

All wood forms or polystyrene/plywood sections shall be securely held in place by nails, waterproof adhesive, or other means approved by the Engineer. Internal cells shall be completely sealed so no plastic concrete is allowed to enter the formed cell.

(D) Removal of Falsework and Forms:

(1) General Requirements:

No falsework or forms shall be relieved of load and no forms shall be removed without approval of the Engineer.

Falsework, excluding bridge deck cantilevered overhangs for cast-in-place prestressed structures, shall not be removed until after the prestressing steel has been tensioned and a minimum of 72 hours after the prestressing steel has been grouted. Falsework for the cantilevered bridge deck overhang shall be removed prior to prestressing but shall not be removed within seven days of concrete placement unless the concrete has attained a minimum compressive strength of 3,000 pounds per square inch. In no case shall falsework be removed within five days of concrete placement. On bridges with both transverse and longitudinal stressing, the deck or overhang falsework shall not be removed until after the transverse prestressing has been completed unless shown otherwise on the plans. The deck overhang falsework shall then be removed prior to performing the longitudinal prestressing.

Falsework for cast-in-place non-prestressed structures or composite superstructures, excluding concrete above the bridge deck, shall not be removed until either:

(a) At least 10 days after the last concrete has been placed in each continuous span and until the compressive strength of all placed concrete has attained at least 70 percent of the required 28-day compressive strength; or

(b) At least five days after the last concrete has been placed in each continuous span and until the concrete has attained the required 28-day compressive strength.

The sloped exterior girders of cast-in-place box girder bridges shall be laterally braced or supported until the top slab (deck) concrete has been placed and has attained at least 70 percent of the required 28-day compressive strength.

Side forms for footings, beams, girders, box culverts, columns, railings, curbs, or other members wherein the forms do not resist dead load bending may be removed after the concrete has set, and the contractor shall cure and protect the concrete thus exposed in accordance with the requirements of Section 1006 of the specifications. The contractor shall assume all risks and responsibility resulting from such removals. Forms for cast-in-place concrete, unless otherwise specified herein, shall not be removed until at least seven days after concrete has been placed in the forms, without the approval of the Engineer.

Placement of backfill material shall be in accordance with Subsection 203-5.03(B) of the specifications. Where backfill is to be placed against both sides of a structural element, the backfill elevations on one side of the element shall not exceed the backfill elevations on the opposite side of the element by more than 5 feet.

Forms for precast concrete shall stay in place a minimum of eight hours.

The period of time between the placement of concrete in the top slab of a standard concrete box culvert (12 foot span or less) and the removal of the slab support forms may be reduced to 48 hours if the top slab remains supported along the center line of the culvert span by a continuous beam and line of posts erected as a part of the original slab form, and which remains in place, undisturbed, a minimum of seven days.

If the Engineer allows the removal of forms before the specified curing period has elapsed, the contractor shall cure the concrete for the remaining required curing time by one of the methods specified in Section 1006 of the specifications.

Forms for cast-in-place concrete above the bridge decks that require a Class II finish may be removed after the concrete has set, providing the required surface finishing of the concrete is completed within four days. If finishing cannot be completed within four days, the forms shall remain in place for seven days.

All forms shall be removed, except forms used to support the deck of box girders when no permanent access to the cells is available.

Care shall be taken in removing falsework and forms so as not to deface or damage the structure. Methods of removal likely to damage or cause overstressing of the concrete shall not be used.

All falsework shall be removed from under bridge superstructures prior to opening the structure to traffic. Falsework shall be removed in such

a manner that excessive stresses are not induced into the structure. Holes shall not be drilled into the structure to facilitate removal of the falsework. Round blockouts may be used for such purpose providing the contractor can submit evidence that the blockouts are not detrimental to the structure and the Engineer approves the use of the blockouts. The maximum blockout diameter shall not exceed 6 inches.

(2) Submittals:

The contractor shall submit to the Engineer, prior to a pre-activity meeting, the methods and sequences of falsework removal, including all equipment the contractor plans to use in removing the falsework. The falsework removal sequence shall consider load transfer when portions of the falsework have been removed, and the load is being carried by still in-place falsework. The falsework removal plan shall be reviewed and approved by a qualified person selected by the contractor before submission to the Engineer. A qualified person, as defined by OSHA, is one who by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated their ability to solve or resolve problems relating to the subject matter, the work, or the project. The contractor shall submit documentation of that person's status as the qualified person to the Engineer. No falsework removal shall take place until the contractor's approved falsework removal plan has been reviewed and approved by the Engineer.

The falsework removal plan shall include a hazard assessment, shall identify the contractor's safety superintendent, and shall include plans to secure the area underneath the falsework and adjacent areas, including work zones and roadways that are within the potential fall zone of any equipment or falsework components while removal operations take place. No personnel shall be permitted under the falsework suspended by a hoisting system, unless the falsework components are secured by an additional temporary load support system. The contractor's safety superintendent will be responsible for the safety of all personnel allowed into the area beneath and adjacent to falsework during falsework removal activities.

A pre-activity meeting shall occur prior to any falsework removal. During the pre-activity meeting, the contractor shall provide the Engineer any necessary changes to the falsework removal plan, the area needed for falsework removal, and any impact the falsework removal has on public safety, project schedule, traffic, and project activities not related to falsework removal.

601-3.03 Placing Concrete:

(A) General Requirements:

No concrete shall be placed until the placement of reinforcing steel and the adequacy of the forms and falsework have been approved by the Engineer.

Adequate time shall be given to the Engineer to check all form dimensions, embedded items, and placement of reinforcing steel. Concrete shall not be placed until all necessary corrections have been made and all work required for the proposed pour has been completed.

Reinforcing steel shall be placed in accordance with the requirements of Section 605 of the specifications and the plans.

The sequence of concrete placement shall be as shown on the project plans or as approved by the Engineer when not shown on the project plans.

Concrete shall be placed and consolidated by methods that do not cause harmful segregation and result in a dense homogeneous concrete free of honeycomb or voids.

Concrete shall be placed in horizontal layers not more than 24 inches in depth unless otherwise approved by the Engineer.

Concrete shall be placed as nearly as possible in its final position and the use of vibrators for shifting the mass of fresh concrete will not be permitted. Dropping the concrete more than 8 feet without the use of approved pipes or tubes will not be allowed.

Care shall be taken to fill all areas within the forms and to force the concrete under and around the reinforcement without displacing the reinforcement or other embedded items.

Conveying equipment shall be capable of providing a supply of concrete to the point of placement without segregation, or interruptions sufficient to permit loss of plasticity between successive increments.

Concrete placed in slabs and floors other than bridge decks shall be struck off by means of a screed. The screed may be self-propelled screed equipment or the type specified under Subsection 401-3.04(D) of the specifications.

No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the structure.

The rate of concrete placement and consolidation shall be such that the formation of cold joints within monolithic sections of any structure does not occur. Any portion of any structure displaying apparent cold joints will be rejected, unless the contractor, at no additional cost to the Department, can submit evidence that indicates that either a cold joint does not exist or that a cold joint is not detrimental to the structure. The Engineer shall be the sole judge in determining the existence of a cold joint and whether its existence is detrimental to the structure. The rate of concrete placement for major structures shall not be less than 35 cubic yards per hour unless otherwise specified or approved in

writing by the Engineer. This rate shall not apply to precast concrete items.

The rate of concrete placement for the bottom slabs and girder walls of cast-in-place box girder superstructures shall not be less than 60 cubic yards per hour when the volume of concrete to be placed exceeds 300 cubic yards.

A post-pour inspection report with at least the following information shall be submitted to the Engineer within 7 days after the production of minor precast structures. The post-pour inspection reports shall include:

(1) Type of product;
(2) Product mark or type ID;
(3) Date of casting;
(4) Mix design;
(5) Concrete strength(s);
(6) Lengths, widths, and heights;
(7) Reinforcing steel size;
(8) Reinforcing steel placement;
(9) Insert and embed locations;
(10) Lifting device locations; and
(11) Damage requiring a repair procedure submittal

In addition to the above information, the production of precast bridge structures post-pour inspection reports shall include:

(12) Projected strand locations;
(13) Camber;
(14) Sweeps; and
(15) Patched hold-down holes

(B) Bridge Deck:

The placing of concrete is not permitted until the Engineer is satisfied that the rate of producing and placing concrete shall be sufficient to complete the proposed pour and finishing operations within the scheduled time, that experienced concrete finishers are available to finish the deck and that all necessary finishing tools and equipment are on hand at the site of the work and are in satisfactory condition for use.

Concrete shall be placed for the full width of the panel to be poured. After the concrete has been placed it shall be consolidated and then struck off by means of self-propelled screed equipment.

Screed equipment shall be designed to operate as close as practicable to bridge curbs or other obstructions.

Screed equipment shall travel on steel rails. Rails shall be substantially supported by adjustable steel supports of adequate size securely fastened in place and spaced at sufficiently close intervals to prevent

any appreciable deflection in the rails. Steel supports shall be of such types and installed in such manner that when the rail and adjustable support have been removed, there are no voids in the concrete.

The steel rails for placing and finishing equipment shall be set to the correct elevation shown on the project plans or as established by the Engineer. The rails shall extend beyond both ends of the scheduled length for placement a sufficient distance that permits the screed and finishing equipment to reach all areas of the concrete placed.

Placement of the deck concrete shall be in accordance with the placing sequence shown on the project plans. The contractor shall submit drawings showing the placement sequence, construction joint locations, directions of the concrete placement, and any other pertinent data to the Engineer for review. The drawing shall be submitted at least four weeks prior to the date of deck placement.

Screed beams or rollers shall be made of metal, or the bottom of the beam shall be metal clad. Roller screeds shall be constructed so that there is no sag or deflection in the screeds.

Screed assemblies shall be equipped with vibrators. The screed assemblies shall be so designed that the vibrating units do not contact any reinforcing steel. Vibration shall be transmitted to the concrete in such a manner that when the motion of the machine is stopped, all vibration ceases.

A slight excess of concrete shall be maintained in front of the screed at all times during the screeding operation. The screed shall make as many passes over the slab as may be necessary to obtain a uniform surface.

The contractor shall furnish a minimum of two transverse work bridges from which floating, straight edging, and curing operations may be accomplished. The work bridges shall be reasonably rigid and free of excessive deflections. The self-propelled mechanical bridge used for texturing the bridge deck may be substituted for one of the required work bridges.

The floating operation shall follow the screeding if required. The float shall have a minimum diameter of 3 inches and have a minimum length of 12 feet. The float shall be constructed so that the surface is maintained true at all times.

Prior to placing concrete, the screed shall be traversed the length of the proposed pour and the clearance from the screed to the reinforcing steel and deck thickness shall be checked. The method of determining the clearance shall be approved by the Engineer prior to making such checks. The clearance shall be as indicated on the project plans with a permissible variation of ± 1/4 inch. Deflection of the screed rails as a result of the weight of the screed equipment will not be permitted. All

corrections necessary as a result of this operation shall be performed prior to beginning the pour.

(C) Pumping Concrete:

Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be of suitable type and shall have adequate capacity for the work. The concrete shall not flow either over or through any piping, fittings, or equipment which is fabricated of aluminum or aluminum alloys. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. Excessive segregation due to high velocity discharge of the concrete will not be permitted. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there is no contamination of the concrete or segregation of the ingredients. Standby equipment shall be readily available to replace initial pumping equipment should breakdown occur.

(D) Vibrating Concrete:

All concrete in structures shall be consolidated by means of approved vibrators together with any other equipment necessary to perform the work as specified herein. The minimum frequency of the internal vibrators shall be 8,000 vibration cycles per minute.

Vibration shall be applied in the area of the freshly deposited concrete. Vibrators shall penetrate to the bottom of the concrete layer and at least 6 inches into the preceding layer. The vibration shall be of sufficient duration and intensity to consolidate the concrete thoroughly within 15 minutes after it has been deposited in the forms.

Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

Re-vibration of concrete may be required at any time as directed by the Engineer.

The contractor shall provide sufficient equipment to ensure uninterrupted and continuous vibration of concrete.

(E) Placing Concrete in Water (Tremie Concrete):

Tremie concrete shall be deposited in water only if either specified on the project plans or when directed and then only under the Engineer's supervision. When depositing in water is allowed, the concrete shall be carefully placed in a compact mass in the space in which it is to remain by means of a tremie, bottom dump bucket, or other approved method that does not permit the concrete to fall through the water without adequate protection. The concrete shall not be disturbed after being

deposited. No concrete shall be placed in running water and forms which are not reasonably watertight shall not be used for holding concrete deposited under water.

A head of concrete shall remain above the discharge end of the tremie tube at all times.

(F) Bridge Deck Widening and Phased Construction:

Where the roadway portion of a bridge deck widening or a deck phased construction section is more than 12 feet in width, concrete shall be placed in the roadway portion in accordance with the requirements of Subsection 601-3.03(B) of the specifications.

Where the roadway portion of a bridge deck widening or a deck phased construction section is 12 feet or less in width, the spreading and floating of concrete in the roadway portion shall conform to the requirements of Subsection 401-3.04(D) of the specifications.

(G) Pedestrian Rail and Fence:

This work shall consist of furnishing and constructing Combination Pedestrian-Traffic Bridge Railing, Pedestrian Fence for Bridge Railing, and Two-Tube Bridge Rail, including all hardware and materials, in accordance with the requirements of the project plans.

(H) Bridge Barriers and Transitions:

This work shall consist of furnishing and constructing Bridge Concrete Barrier and Transition, including all hardware and materials, in accordance with the requirements of the project plans.

(I) Approach and Anchor Slabs:

This work shall consist of furnishing and constructing reinforced concrete approach and anchor slabs for bridges, including all tools, equipment, labor, and materials. All work shall be in accordance with the details shown on the project plans and the requirements of these specifications.

601-3.04 Joints in Major Structures:

(A) Construction Joints:

Construction joints shall be placed in the locations shown on the project plans or as approved by the Engineer. Except under emergency conditions, construction joints shall be planned and located in advance of placing concrete. All construction joints shall be perpendicular to the principal lines of stress and in general located at points of minimum shear and moment.

Construction joints shall be constructed in accordance with the details shown on the project plans or as directed by the Engineer. Before new concrete is placed against concrete which has hardened, forms shall be drawn tight against the face of the concrete, wood keys shall be removed and the exposed steel or dowels and the entire surface of the construction joint shall be thoroughly cleaned. Immediately ahead of placing fresh concrete on the construction joint, the old concrete shall be thoroughly saturated with water.

After placing of concrete has been completed to the construction joint and before placing fresh concrete, the exposed reinforcing steel and the entire surface of the construction joint shall be thoroughly cleaned of surface laitance, curing compound and other materials foreign to the concrete and clean, coarse aggregate exposed. Surfaces of concrete that have been in place for eight hours or more shall be cleaned by abrasive blast methods. Surfaces of concrete that have been in place for less than eight hours may be cleaned with air and water jets provided that surface laitance and curing compound is removed.

After the concrete surfaces have been treated as specified, they shall be cleaned of all dust and abrasive material.

(B) Deck Joint Assemblies:

(1) Description:

This work shall consist of furnishing and installing expansion devices including the seals, anchorage system and hardware in conformity with the project plans and the requirements of these specifications.

(2) Materials:

Elastomer seals shall be of the Compression Seal or Strip Seal type and shall conform to the requirements of Subsection 1011-5 of the specifications.

Steel shapes and plates shall conform to the requirements of ASTM A572 Grade 50, ASTM A588 Grade 50, ASTM A709 Grade 36 or Grade 50W, or as shown on the plans.

(3) Construction Requirements:

(a) General:

Deck joint assemblies shall consist of elastomer and metal assemblies which are anchored to the concrete at the joint. The seal armor shall be cast in the concrete. The completed assembly shall be in planned position, shall satisfactorily resist the intrusion of foreign material and water and shall provide bump-free passage of traffic.

For each size of seal on a project, one piece of the material supplied shall be at least 18 inches longer than required by the project plans. The additional length will be removed by the Engineer and used for testing by ADOT Materials Group. Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

(b) Fabrication

Fabrication of all metal for deck joint assemblies shall be in accordance with the requirements of Subsection 604-3.02 of the specifications.

The deck joint assemblies' fabrication plant shall be certified under the AISC Quality Certification program as a Certified Bridge Fabricator-Simple (SBR), or higher.

All welding shall be in accordance with the requirements of Subsection 604-3.06 of the specifications.

All metal parts of deck joint assemblies shall be galvanized after fabrication in accordance with the requirements of ASTM A123 and A153, unless ASTM A588 or ASTM A709 Grade 50W steel is used. Bolts shall be high strength, conforming to the requirements of ASTM F3125 Grade A325, with a protective coating according to the requirements of ASTM F1136 Grade 3.

Metal parts of compression seal assemblies do not require galvanizing, plating, or painting.

(c) Shop Drawings:

Prior to fabrication, the contractor shall submit shop drawings to the Engineer for approval in accordance with the requirements of Subsection 105.03 of the specifications. The shop drawings shall show complete details of the method of installation to be followed, including a temperature correction chart for adjusting the dimensions of the joint according to the ambient temperature and any additions or rearrangements of the reinforcing steel from that shown on the project plans.

Deck joint assemblies for prestressed concrete structures shall be installed at the narrowest joint opening possible to allow for long term creep.

(d) Elastomer Seals:

Seals shall conform to the requirements hereinbefore specified.

(e) Joint Preparation and Installation:

The contractor shall form the joint with a secondary concrete pour. The surface of the existing concrete shall be coated prior to the concrete being placed with an approved adhesive specifically formulated for bonding new concrete to old concrete.

Joints to be sealed shall be covered or otherwise protected at all times prior to installing the elastomer portion of the assembly. The elastomer shall be installed at such time and in such manner that it is not damaged by construction operations.

The seal element shall be installed subject to these specifications and the approval of the Engineer. Immediately prior to the installation of the seal element, the metal contact surfaces of the joint armor shall be clean, dry, and free of oil, rust, paint, or foreign material. Any perforation or tearing of the seal element due to installation procedures or construction activities will be cause for rejection of the installed seal element.

The contractor shall take due care in the placement of the concrete under and around the joint rails to ensure that proper consolidation is achieved. After placement, the Engineer shall inspect the joint for voids by sounding the angle with a hammer. All voids shall be repaired by the contractor by epoxy injection at no cost to the Department.

(C) Water Stops:

Water stops of rubber or plastic, shall be placed in accordance with the details shown on the project plans. Where movement at the joint is provided for, the water stops shall be of a type permitting such movement without injury. They shall be spliced, welded, or soldered, to form continuous watertight joints.

(D) Joints in Deck Units:

After erection and at the time directed by the Engineer, the longitudinal joints or shear keys shall be thoroughly packed with a pre-packaged non-shrink grout or a sand-cement grout with an expansion agent approved by the Engineer. The contractor shall then transversely connect the deck units with the connection rods, stressing and anchoring them as shown on the project plans.

601-3.05 Finishing Concrete:

(A) General Requirements:

The appropriate finish, as specified herein, shall be applied to each surface of all concrete structures.

All formed surfaces shall require a Class I Finish. Formed surfaces shall be finished immediately after the removal of forms in accordance with the requirements specified herein. If rock pockets or honeycomb are of

such an extent and character as to affect the strength of the structure and to endanger the steel reinforcement, the Engineer may declare the concrete defective and require the removal and replacement of that portion of the structure affected at the expense of the contractor.

Formed surfaces normally in view of vehicular or pedestrian traffic, or not covered by fill material shall present a satisfactory appearance of uniform color and texture commonly achieved by the use of clean, smooth plywood forms joined tightly or taped at the joints, preformed metal forms, paper tubing forms, or specially-coated forms. If a satisfactory appearance has not been achieved, either in the formed surface or at the joints, the Engineer will order that the surface be finished in accordance with the requirements for a Class II Finish.

(B) Class I Finish:

All bolts, wires, snap-ties, and rods shall be clipped and recessed 1 inch below the surface of the concrete. All holes, honeycomb, rock pockets, and other surface imperfections shall be cleaned to sound concrete, thoroughly moistened and carefully patched with mortar. All holes as a result of forming or other methods of construction utilized by the contractor shall be cleaned thoroughly, then completely filled with and carefully patched with mortar.

Mortar shall be composed of one part cement, two parts of fine sand, water, and an adhesive of a type approved by the Engineer. A portion of the required cement shall be white as required to match the color of the surrounding concrete. Small voids due to entrapped air and water in precast concrete items need not be patched.

(C) Class II Finish:

The surface shall be patched and pointed as specified herein for Class I finish. When the mortar used in patching and pointing has set sufficiently, the surface shall be rubbed with cork, wood, or rubber floats, polystyrene, or a mechanical carborundum stone. During the rubbing process a thin mortar, matching the color of surrounding concrete, may be used to facilitate producing a satisfactory lather. The mortar used to produce lather shall not be used in quantities sufficient to cause a plaster coating to be left on the finished surface. Rubbing shall continue until irregularities are removed and there is no excess material. At the time a light dust appears, the surface shall be brushed or sacked. Brushing or sacking shall be carried in one direction so as to produce a uniform texture and color.

(D) Finishing Bridge Deck:

(1) General:

Bridge decks that will receive an overlay, sawed grooves, diamond grinding or waterproofing membrane shall be lightly textured with a

burlap drag, broom finish, or other engineer approved drag type texturing during the plastic concrete state, after the finishing operation and smoothness test, as specified below, and prior to the curing process. Bridge decks exposed directly to traffic shall be grooved or tined as specified in Subsection 601-3.05(D)(2) of the specifications.

The finishing operation shall be completed before the water sheen disappears. The deck surface shall be finished to a smooth floated surface, free of mortar ridges, hollows, and any other projections. Water shall not be applied to the deck surface at any time during floating or finishing except that a fine fog mist may be applied as approved by the Engineer.

Fogging equipment shall be capable of applying water to the concrete in form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete. The fine fog mist shall be applied at a distance not to exceed 12 inches from the surface. Application by brushes or any other method that concentrates water will not be permitted.

Excess concrete, mortar, or paste produced by the finishing process shall not be discarded into areas of the bridge deck to be covered by sidewalks, medians, curbs, or parapets, or otherwise incorporated into the work, but shall be removed and disposed of properly.

The finished surface of the concrete shall be tested with a 10-foot straightedge placed on the deck surface. For deck surfaces exposed directly to traffic, the surface plane shall not vary by more than 1/8 inch, as measured from the bottom of the straightedge. Deck surfaces to be covered with a special riding surface or waterproofing membrane shall not vary by more than 1/4 inch, as measured from the bottom of the straightedge.

Deck surface areas tested during the plastic state that do not meet the smoothness criteria specified above shall be corrected immediately, refinished, and retested. All corrected areas shall be textured to match the finish of the surrounding deck surface.

Should the deck surface require additional corrections or repair after the concrete has cured, as determined by the Engineer, such work shall be in accordance with Subsection 105.04 of the specifications. If the bridge deck corrections require mechanical grinding, all corrected areas shall be re-textured with sawed grooves to match the finish of the surrounding deck surface. After such corrective grinding and re-grooving is completed, the minimum remaining cover over the reinforcing steel shall be not less than 2-1/4 inches.

(2) Grooving and Tining:

(a) General Requirements:

Unless longitudinal grooving is specified on the plans, the contractor shall texture the bridge deck, approach slab, and anchor slab with transverse grooves.

Grooves shall be placed with tine brooming while the concrete is still plastic; however, if an item for Bridge Deck Texturing (Sawed Grooves) is included in the bidding schedule, the bridge deck, approach slab, and anchor slab shall be textured with sawed grooves after the concrete has been cured.

A uniform textured surface of grooves shall be installed for the entire length of the bridge deck, approach slabs, and anchor slabs, except for those areas occupied by devices installed on the deck.

Widened bridge decks shall be finished to match the existing deck surface texture.

Bridge sidewalks shall be textured to a light broomed finish during the plastic concrete state.

(b) Tine Brooming:

Tine broom texturing shall occur after the Engineer has accepted the smoothness of the finished surface, and during the plastic concrete state, but prior to the curing process.

The tined grooves shall terminate at 12 inches ± 3 inches from the face of curbs, bridge rails or median dividers along each edge of the bridge deck surface. Texturing shall be stopped 9 inches to 12 inches from any devices installed on the bridge deck, including scuppers and expansion devices, whether perpendicular to the tined grooves or skewed.

The apparatus producing the texture grooves in the plastic concrete shall be mechanically operated from an independent self-propelled bridge. The bridge shall be used for texturing only, and shall be supported on the same steel rails used for the screed equipment. The tine brooming equipment shall be capable of producing grooves which meet the dimensional requirements specified in Subsection 601-4.01 of the specifications.

The timing of the texture operation in the plastic concrete is critical. The texturing shall be completed before the surface is torn or unduly roughened by the texturing operation. Grooves that close following the texturing will not be permitted.

Hand tine brooms shall be provided and available at the job site at all times when texturing plastic concrete.

(c) Sawed Grooves:

(i) General:

Sawed groove texturing shall occur after the Engineer has accepted the finished surface, and after the concrete has cured for at least seven days, but before the roadway is opened to traffic. Grooving shall occur prior to the application of any concrete sealer if a sealer is specified in the contract documents.

A self-propelled texturing machine built for grooving of concrete surfaces shall be used for making the sawed grooves. The saw grooving equipment shall be capable of producing grooves which meet the dimensional requirements specified in Subsection 601-4.01 of the specifications.

Sawed groove texturing shall terminate at 12 inches ± 3 inches from the face of curbs, bridge rails, or median dividers along each edge of the bridge deck surface. Texturing shall be stopped 9 inches to 12 inches from any devices installed on the bridge deck, such as scuppers and expansion devices that are perpendicular to the grooves.

For skewed expansion devices on the bridge deck, the direction of the grooves as specified above shall not be altered, and texturing shall terminate no closer than 6 inches nor farther than 4 feet from the joint armor. The maximum gap in texturing, from one side to other of skewed expansion devices, shall not exceed 5 feet.

Overlapping of grooves by succeeding passes will not be permitted.

(ii) Equipment:

The self-propelled texturing machine shall have diamond-tipped circular saw blades mounted on a multi-blade arbor, and shall have a depth control device that detects variations in the deck surface and adjusts the cutting head height to maintain the specified depth of the groove. The texture machine shall also include devices to control alignment. Single blade equipment may be authorized by the Engineer where multi-blade assemblies are not capable of sawing to within 1 foot of obstructions. Flailing or impact type grooving equipment shall not be used.

The grooving equipment shall be equipped with vacuum slurry pickup equipment which shall continuously pick up water and sawing dust, and pump the slurry to a collection tank.

(iii)Construction:

The contractor shall submit a plan detailing the proposed layout of the texturing to the Engineer for approval at least seven days prior to the grooving operations. Spacing dimensions at the starting and ending point of each pass shall be noted. A description of the saw cutting equipment shall be included.

Prior to grooving operations, the contractor shall provide two gauges, designed for verification of groove depth, to the Engineer for approval. The gauges shall be accompanied by the manufacturer's instructions for their use. During grooving operations the contractor shall check the groove dimensions, under the observation of the Engineer, at random locations. If the minimum groove depth has not been achieved, the grooving operation shall stop and the necessary adjustments shall be made.

At the beginning of each work shift, the contractor shall furnish a full complement of saw blades for each texturing machine that are capable of cutting grooves of the specified width, depth, and spacing.

If during the work a single grooving blade on a machine becomes incapable of cutting a groove, the contractor shall continue work for the remainder of the work shift. It will not be required to cut the groove omitted resulting from the failed blade. If two or more grooving blades on a machine become incapable of cutting grooves, the contractor shall cease operating the machine until it is repaired.

The contractor shall continuously remove all slurry from the equipment throughout the grooving operations with a vacuum pickup, and shall dispose of the slurry at an approved off-site location, and in accordance with applicable laws and ordinances for disposal. All textured areas shall be flushed with clear water as soon as possible to remove any slurry material not collected by the vacuum pickup. Flushing shall be continued until all surfaces are clean and accepted by the Engineer.

The contractor shall repair all damage to the expansion devices caused by the grooving operation in a manner satisfactory to the Engineer. If the Engineer determines that the expansion device cannot be repaired in a manner which allows proper functioning of the system, the contractor shall replace the device at no additional cost to the Department. The replacement shall be a new expansion device equal in all respects to the expansion device being replaced.

Damage to any other portion of the bridge deck, or to anything attached or embedded in the bridge deck, that is attributable to the contractor's operations shall be repaired in a manner satisfactory to the Engineer at no additional cost to the Department.

601-3.06 Curing Concrete:

Curing cast-in-place concrete and precast concrete items shall be in accordance with the requirements of Subsection 1006-6 of the specifications.

601-3.07 Supporting, Handling, Transporting, and Erecting Precast Concrete Items:

(A) Plant Operations:

(1) General:

Precast bridge structures shall be handled or supported at or near the final bearing points for storage.

All Precast concrete items shall meet the designed compressive strength requirements for release prior to initial lifting from the casting bed. The release strength shall be as shown on the plans.

All precast concrete items shall be legibly stenciled with a waterproof paint and include, at a minimum, the following:

(a) Manufacturer's name or logo;
(b) Date of production ;
(c) Description of the product; and
(d) Mark number

All applicable manufacturer stenciling shall be applied at the manufacturer's plant.

All precast concrete items shall not be delivered to the project site without an ADOT stencil. Precast items will not be stenciled by ADOT until it has reached the 28-day compressive strength requirement.

No precast concrete items shall be shipped for at least 14 days after concrete placement, and until it meets 28-day compressive strength, unless otherwise approved by the Engineer.

Until precast concrete items have been approved, they shall be stored in a manner that allows the inspector full access around each item to perform inspections.

When lifting precast concrete items from the production bed, setting in storage, loading for delivery, erecting, or placing at the project, each precast concrete item shall be lifted from the lifting points in a manner that does not cause structural damage to the product(s) due to stresses, torsion, or other forces.

Precast concrete items shall be supported during transporting in a manner that allows conformity to the proper bearing points. At all times, the items shall be handled or supported securely in an upright position.

Items that have been damaged in shipment will be rejected at the point of delivery.

Lifting devices shall not project above the surface of the item after placement unless they are embedded in a subsequent concrete pour, have a minimum concrete cover of 2 inches, and do not interfere with the placement of reinforcing steel or concrete.

All repairs shall match the color of the concrete being repaired. Patching materials used shall be free of chlorides and meet or exceed the 28-day concrete compressive strength requirements shown on the plans.

All precast concrete items, with the exception of concrete pipe, shall meet the dimensional tolerance requirements of Subsection 601-4.02(B) of the specifications. Concrete pipe dimensional tolerances shall meet the requirements of Subsection 601-3.07(A)(4) of the specifications.

(2) Precast Bridge Structures Plant Operations:

Precast bridge structures shall be stored on suitable supports placed on level, well compacted material with adequate drainage. Bridge structures shall be stored in a manner that prevents sweeps or damage. When requested by the Department, the manufacturer shall re-set any bridge structure that is not level.

When precast bridge structures are to be stored for more than 60 days after release strength is achieved, the manufacturer shall coordinate with the contractor to address any potential camber issues. The Engineer shall be given written notification of precautions taken.

All minor repairs, such as bottom corner spalls and hold-down holes, shall be made with a “High Strength, Non-Shrink” grout which is listed on the Department’s APL. Prior to patching, hold-down holes shall be cleaned of deleterious materials, grease, oil, and laitance. Cracks at the end of girders shall be pressure injected with an epoxy adhesive. Approved epoxy adhesives are listed on the Department’s APL.

All major repairs shall require the submittal of a repair procedure for review and approval. Examples of a major repair are: dimensions deviating from specified tolerances, exposed cable strand, concrete voids, missing inserts or pipes, and required projected strand that has been cut off. The contractor shall notify the Engineer immediately of these or other defects before submitting a repair procedure.

(3) Minor Precast Structures Plant Operations:

Minor precast structures shall be stored on level, well compacted material with adequate drainage. Minor precast structures shall be stored in a manner that prevents damage. When requested by the Engineer, the manufacturer shall reset any precast concrete items that are not level.

All minor repairs, such as corner spalls and cracks, shall be made with a “High Strength, Non-Shrink” grout which is listed on the Department’s APL. Prior to patching, the area to be patched shall be cleaned of deleterious materials, grease, oil, and laitance.

All major repairs require the submittal of a repair procedure for review and approval. Examples of a major repair may include concrete voids, missing inserts, and missing embeds. The contractor shall notify the Engineer immediately of these or other defects before submitting a repair procedure.

(4) Precast Concrete Pipe:

The dimensional tolerance requirements shall meet the appropriate specifications for the pipe used on the project. Such specifications may include, but are not limited to: AASHTO M 86, M 170, M 206, M 207, and M 242.

All gauges used for the determination of “D Load”, three edge bearing load, hydrostatic pressure, and other required testing shall be visible from a distance of at least 10 feet.

When D-Load testing is required for the specified pipe, the frequency of D-Load testing shall be at least one test for 100 joints per size and class for delivery. Concrete pipe meeting the specifications shall have a date range to cover the 100 joints of no more than the previous six months. When the quantity of pipe is less than 10 joints, the D-Load test requirement may be waived per the inspector’s discretion. Any pipe that fails to meet the D Load requirement shall require at least two additional tests. If any of the additional tests fail, the pipe will be considered unacceptable for that specific class or D Load requirement.

Pipe failing a specific class or D-Load may be downgraded to a lower class provided the pipe meets the lower class specifications. If concrete pipe is downgraded, the pipe shall have the original class or D-Load removed from the pipe and the new class stenciled in its place.

(B) Bridge Girder Erection:

Girders shall be placed accurately on bearings to avoid creating eccentricities capable of initiating imbalance.

Girders with shapes that exceed a height to width ratio of two shall be temporarily braced. The girder width shall be determined from the outside dimension of the bottom flange.

The contractor shall secure such girders in position on the structure with temporary lateral bracing to resist loads as specified in the AASHTO Guide Design Specifications for Bridge Temporary Works. Lateral bracing shall be designed to allow for girder temperature movements.

The bracing shall be placed prior to the release of the erection equipment from each girder.

Prior to erection of any girders, the contractor shall provide a lateral bracing plan, prepared and sealed by a Professional Engineer registered in the State of Arizona, for the Engineer's review. Such bracing plan shall be included with the working drawings specified in Subsection 105.03 of the specifications, and shall include supporting calculations. A girder pre-erection meeting shall be scheduled following the review and prior to erection of any girders. All parties involved in the installation shall be represented, and no girders shall be placed until the plan has been approved.

No traffic shall be allowed under each newly erected girder until the girder has been laterally braced.

Temporary bracing shall remain in place until after permanent concrete diaphragms are installed at the bents, or the girder is integrated with a permanent feature that restricts the girder's lateral movement.

601-3.08 Backfilling:

Structure backfill shall be placed in accordance with the requirements of Subsection 203-5.03(B) of the specifications.

601-3.09 Vertical Restrainers:

(A) Description:

The contractor shall furnish and install restrainer units consisting of cables and assemblies and associated materials or components in conformance with the details shown on the project plans, and in accordance with the specifications.

Components required for each restrainer unit type will be detailed on the project plans and shall include various combinations of the following: cables, clips, No. 11 rebar, duct tape, expanded polystyrene, hardboard, and incidentals.

(B) Materials:

Cables shall be 3/4 inch diameter preformed, 6 by 19 wire strand core, or independent wire rope core (IWRC), galvanized ASTM A603 Class A coating, right regular lay, manufactured of improved plow steel with a minimum breaking strength of 21 tons. Two certified copies of mill test reports of each manufactured lengths of cable used shall be furnished to the Engineer.

Free ends of cable restrainer units shall be securely wrapped at each end to prevent separation.

The cable assemblies shall be shipped as a complete unit.

A minimum of one test loop assembly per bridge or one test loop assembly for every 40 cable assemblies, whichever is greater, shall be furnished to the Engineer for testing. The test loop assembly shall be fabricated from the same lot of material, wire rope and fittings or clips as the cable assemblies. The test loop assembly shall be not less than 27 inches or more than 33 inches long when pulled taut.

Tempered hardboard shall be 1/8 inch minimum in thickness, unless shown or specified otherwise. Hardboard shall conform to the requirements of ANSI 135.4.

Expanded polystyrene shall be a commercially available polystyrene board. Expanded polystyrene shall have a flexural strength of 35 pounds per square inch minimum determined in accordance with ASTM C203, and compressive yield strength between 16 and 40 pounds per square inch, at 5 percent compression. When shown on the plans, surfaces of expanded polystyrene shall be faced with hardboard.

Other facing materials may be used provided they furnish equivalent protection. All boards shall be held in place by nails, waterproof adhesive, or other means approved by the Engineer.

(C) Construction Requirements:

Restrainers shall be installed as indicated on the project plans.

The contractor shall provide means of holding the cable assemblies in their planned positions.

The contractor shall be responsible for determining the required length of the cable assemblies.

601-3.10 Foundations:

Foundations for structures shall be placed on suitable earth or rock bearing, on a concrete foundation seal, or on piling, as shown on the project plans. Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of the specifications. No concrete shall be placed under water or against water-bearing strata, except where a tremie concrete procedure is allowed by the Engineer.

601-4 Tests on Finished Structures:

601-4.01 Surface Texture:

The grooves for decks exposed directly to traffic shall be rectangular in shape and shall be 1/8 inch ± 1/32 inch deep by 1/8 inch ± 1/32 inch wide. Spacing of the grooves shall be 3/4 inches ± 1/8 inch center to

center. The textured groove depth will be measured in accordance with the requirements of Arizona Test Method 310.

601-4.02 Dimensional Tolerances:

(A) Cast-in-Place Concrete:

The maximum allowable tolerances or deviations from dimensions shown on the project plans or the approved shop drawings shall be as shown in the following tables:

Table 601-1
Dimensional Tolerances
Cast-In-Place Concrete

Component	Variation (+)	Variation (-)
Cross-sectional dimensions of columns, piers, girders	1/4 inch	1/8 inch
Thickness of slabs and walls	1/4 inch	1/8 inch
Footing cross sections	2 inches	1/2 inch
Footing thickness	No Limit (1)	1 inch (2)
Slabs on subgrade (excluding footing thickness)	1/4 inch	3/4 inch
Girder bearing seats deviation from elevation	1/8 inch	1/4 inch
Box girder overall depth	1/4 inch	1/8 inch
Box girder slab and wall thickness	1/4 inch	1/8 inch
Box girder post-tensioning ducts	1/4 inch	1/4 inch

Notes:

(1) Does not apply to reinforcing steel placement.

(2) Allowable deviation of footing thickness if less than specified is 5% of specified thickness up to a maximum 1 inch.

Table 601-2
Variation/Deviation
Cast-In-Place Concrete

Component	Length	Allowable Variation
Variation from plumb in the lines and surfaces of columns, piers, abutment, and girder walls	≤ 10 feet segment Entire length (Max.)	3/8 inch 1 inch
Girder alignment (deviation from straight line parallel to centerline of girder measured between diaphragms)	Every 10 feet	1/8 inch
Girder bearing seats (deviation from plane surface flatness)	Every 10 feet	1/8 inch

(B) Precast Concrete Structures:

(1) General:

Precast units that do not comply with the dimensional tolerances specified herein will be rejected. Precast units that show evidence of cracks, pop outs, voids, or other evidence of structural inadequacy or imperfections that reduce the aesthetics of the unit after final placement will be rejected.

(2) Precast Concrete I-Beams:

The maximum allowable tolerances of deviations from dimensions and details shown on the project plans or the approved shop drawings shall be as shown in the following table:

Table 601-3
Dimensional Tolerances
Precast Concrete I-Beam

Component	Variation (+)	Variation (-)
Length	3/4 inch	3/4 inch
Width (flanges and fillets)	3/8 inch	1/4 inch
Depth (overall)	1/2 inch	1/4 inch
Width (web)	3/8 inch	1/4 inch
Depth (flanges and fillets)	1/4 inch	1/4 inch
Stirrup bars (deviation from top of beam)	1/4 inch	3/4 inch
Horizontal position of deflection points for deflected strands (placed symmetrically about the center)	10 inches	10 inches
Position of handling devices	6 inches	6 inches
Bearing plates (ctr. to end of beam)	1/4 inch	1/4 inch
Side inserts (ctr. to ctr. and ctr. to end)	1/2 inch	1/2 inch
Bearing area deviation from plane	1/8 inch	1/8 inch
Stirrup bars (longitudinal spacing)	1 inch	1 inch
Position of post-tensioning duct	1/4 inch	1/4 inch
Position of weld plates	1 inch	1 inch
Exposed horizontal beam ends (deviation from square or designated skew)	1/4 inch	1/4 inch
Exposed vertical beam ends (deviation from square or designated skew) per foot of beam depth	1/8 inch	1/8 inch

Horizontal alignment deviation from straight line parallel to center line of member shall not be greater than 1/8 inch per every 10 feet in length.

Bearing plates (center to center) deviation shall not exceed ± 1/8 inch per 10 plates, but not greater than ± 3/4 inch.

Tendon position deviation from center of gravity of strand group and individual strands shall not be greater than ± 1/4 inch.

(3) Precast Concrete Box Beams and Flat Slabs:

The maximum allowable tolerances or deviations from dimensions and details shown on the project plans or the approved shop drawings shall be as shown in the following table:

Table 601-4
Dimensional Tolerances
Precast Concrete Box Beams and Flat Slabs

Component	Variation (+)	Variation (-)
Length	3/4 inch	3/4 inch
Width (overall)	1/4 inch	1/4 inch
Depth (overall)	1/4 inch	1/4 inch
Width (web)	3/8 inch	3/8 inch
Depth (top slab)	1/4 inch	1/4 inch
Depth (bottom slab)	1/4 inch	1/8 inch
Position of tendons (C.G. of strand group)	1/4 inch	1/4 inch
Longitudinal spacing of stirrup bars	1 inch	1 inch
Position of handling devices	6 inches	6 inches
Square ends (deviation from square)	1/2 inch	1/2 inch
Skew ends (deviation from designated skew)	1/2 inch	1/2 inch
Beam seat bearing area (variation from plane surface when tested with a straightedge through middle half of member)	1/8 inch	1/8 inch
Dowel tubes (spacing between the centers of tubes and from the centers of tubes to the ends and sides of items)	1/2 inch	1/2 inch
Tie rod tubes (spacing between the center of tubes and from the centers of tubes to the end of the member)	1/2 inch	1/2 inch
Tie rod tubes (spacing from centers of tubes to the bottom of the beams)	3/8 inch	3/8 inch
Position of side inserts	1/2 inch	1/2 inch
Position of weld plates	1 inch	1 inch

Horizontal alignment deviation from straight line parallel to center line of member shall not be greater than 1/8 inch per every 10 feet in length.

Camber differential between adjacent units shall not be greater than 3/4 inch.

Slab Void position shall not be greater than 1/2 inch from end of void to center tie hole plus an additional inch adjacent to end block.

The total width of deck shall be the theoretical width ± 1/2 inch per joint.

(4) Precast Minor Structures:

The maximum allowable tolerances or deviations from the dimensions shown on the drawings shall be as shown in the following table:

Table 601-5 Cross-sectional Dimensional Tolerances Minor Precast Structures		
Component	**Variation (+)**	**Variation (-)**
Sections 6 inches or less	1/8 inch	1/8 inch
Sections 18 inches or less and over 6 inches	3/16 inch	3/16 inch
Sections 36 inches or less and over 18 inches	1/4 inch	1/4 inch
Sections over 36 inches	3/8 inch	3/8 inch

The dimensional tolerance for the overall dimensions of a member shall be ± 1/4 inch per 10 feet of length, with a maximum of ± 3/4 inch.

Deviations from straight line shall not be more than 1/4 inch per 10 feet of length.

All exposed, sharp corners of the concrete shall be filleted 3/4 inch with a maximum allowable deviation of ± 1/8 inch.

601-4.03 Compressive Strength and Acceptance:

Sampling and testing for compressive strength and acceptance for compressive strength will be in accordance with the requirements of this section and Subsection 1006-7 of the specifications.

601-4.04 Opening to Traffic:

No vehicular traffic will be allowed on the structure until at least 10 days after the last concrete has been placed in each continuous portion of a structure and until the compressive strength of all placed concrete has reached the required 28-day compressive strength on structures in which cast-in-place concrete has been used. For bridge deck joints and closure pours with specified early strength concrete intended to meet an accelerated traffic opening, the engineer may allow opening bridge to traffic, provided the specified early concrete strength specified in the contract document has been met.

No vehicular traffic will be allowed on the structure until after the structure has been prestressed, tendons grouted, and all falsework removed from under the superstructure, for cast-in-place prestressed structures.

601-5 Method of Measurement:

When concrete is to be paid for by the cubic yard, measurement will be made in accordance with the dimensions shown on the plans or such other dimensions as may be ordered in writing by the Engineer. No deduction will be made for the volume occupied by reinforcing steel, structural steel, prestressing materials, or pile ends embedded in the concrete.

The quantity of precast, prestressed structural concrete items shall be measured to the nearest linear foot for each type and size of girder, box beam, or voided slab, as shown on the bidding schedule, installed in place, complete, and accepted. Each member shall include the concrete, steel reinforcement, and prestressing steel, enclosures for prestressing steel, anchorages, plates, nuts, elastomeric bearing pads, and such other materials contained within or attached to the unit.

Deck joint assemblies will be measured by the linear foot. Measurement will be made along the center line of the joint and at the surface of the roadway or sidewalk from face-of-curb or barrier to face-of-curb or barrier. Measurement will be to the nearest linear foot. No measurement will be made for that portion of the deck joint assembly required by plan details to extend through the face-of-curb or barrier, such being considered as included in the sealing of the joint.

Measurement for vertical restrainers will be made for each restrainer acceptably installed in place for each bridge.

Combination Pedestrian-Traffic Bridge Railing will be measured to the nearest linear foot from the outside dimensions of the parapet. Pedestrian Fence for Bridge Railing and Two-Tube Bridge Rail will be measured to the nearest linear foot from end-post to end-post.

Bridge Concrete Barrier and Transition will be measured to the nearest linear foot.

Reinforced Concrete Approach Slab will be measured to the nearest square foot.

Reinforced Concrete Anchor Slab will be measured to the nearest square foot. No measurement will be made for the reinforced concrete anchor lugs.

Bridge Deck Texturing (Sawed Grooves), when included in the bidding schedule, will be measured to the nearest square yard. The area will be determined by the length of the bridge, approach slabs, and anchor slabs, multiplied by the width of the roadway between the face of curb or bridge rail on each side, less 2 feet. The quantity shown on the bidding schedule shall be considered final and will not be re-measured unless changes are specified by the Engineer, or if the Engineer or contractor determines that the constructed area varies by an amount greater or less than 2 percent of the quantity shown on the bidding schedule. Such adjustments, if required, shall be in accordance with Subsection 104.02 of the specifications.

601-6 Basis of Payment:

Class S or Class B concrete, measured as provided above, will be paid for in accordance with the provisions of Subsection 1006-7.03(B)(2) of the specifications.

The contract price paid for Class S or Class B concrete shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in furnishing, placing, and curing concrete and transporting and erecting falsework, forms, precast concrete items, water stops, roadway drains, scuppers, metal hinges, and bearing pads to provide a concrete structure complete in place as shown on the project plans, as specified herein, and as directed by the Engineer.

The accepted quantities of deck joint assemblies, measured as provided above, will be paid for at the contract unit price per linear foot, complete in place, as shown on the plans.

The accepted quantities of Vertical Restrainers, as measured above, will be paid for in accordance with the provisions of Subsection 109.10 of the specifications, Lump Sum Payment for Structures.

Payment for minor structures will be made under the various sections of the specifications covering that particular minor structure.

The accepted quantities of Combination Pedestrian-Traffic Bridge Railing, Pedestrian Fence for Bridge Railing, and Two-Tube Bridge Rail, measured as provided above, will be paid at the contract unit price, complete in place, including all concrete, reinforcing steel, rail, other materials, and labor. Reinforcing steel embedded below the parapet shall be included in the bridge railing.

The accepted quantities of Bridge Concrete Barrier and Transition, measured as provided above, will be paid at the contract unit price, complete in place, including all concrete, reinforcing steel, rail, other materials, and labor. Reinforcing steel embedded below the barrier or transition shall be included in the barrier and transition.

The accepted quantities of Reinforced Concrete Approach Slab, measured as provided above, will be paid for at the contract unit price, complete in place, including all concrete, reinforcing steel, labor, tools, equipment, and incidentals.

The accepted quantities of Reinforced Concrete Anchor Slab, measured as provided above, will be paid for at the contract unit price, complete in place, including all concrete, reinforcing steel, labor, tools, equipment, and incidentals. No payment will be made for furnishing all materials and constructing reinforced concrete anchor lugs, the cost being considered as included in the contract bid item for the reinforced concrete anchor slab.

The accepted quantities of sawed groove texturing, measured as provided above, will be paid for at the contract unit price, complete in place, including all labor, tools, equipment, and incidentals.

No measurement or direct payment will be made for texturing of the bridge deck with a burlap drag or by tine brooming, the cost being considered as included in contract items.

No measurement or direct payment will be made for the temporary bracing of erected girders, or for preparation of the girder bracing plan, the costs being considered as included in contract items.

No separate measurement or payment will be made for fiber additive, the cost being considered as included in the cost of the Class S or Class B concrete.

SECTION 602 PRESTRESSING CONCRETE:

602-1 Description:

The work under this section shall consist of prestressing precast and cast-in-place concrete by furnishing, placing and tensioning of prestressing steel in accordance with the details shown on the project plans, and the requirements of the specifications.

The work under this section shall also include the furnishing and installation of any appurtenant items necessary for the particular prestressing system to be used, including but not limited to ducts, anchorage assemblies, and grout used for pressure grouting ducts for post-tensioning systems and strand deflection devices, such as hold-downs and hold-ups for pretensioning systems.

Prestressing for precast concrete items shall be performed by the pretensioning method.

Prestressing for cast-in-place concrete structures shall be performed by the post-tensioning method.

602-2 Materials:

602-2.01 Reinforcing Steel and Prestressing Steel:

Materials furnished for reinforcing steel shall conform to the requirements of Section 1003 of the specifications.

Prestressing steel shall be high-tensile steel wire, high-tensile seven-wire strand or high-tensile alloy bars, as shown on the project plans.

High-tensile steel wire shall conform to the requirements of AASHTO M 204.

High-tensile seven-wire strand shall conform to the requirements of AASHTO M 203 for Grade 270. In addition to the 0.5-inch diameter prestressing steel shown on the project plans, 0.6-inch diameter seven-wire strand may be used for cast-in-place prestressed structures.

High-tensile alloy bars shall conform to the requirements of AASHTO M 275.

All prestressing steel shall be satisfactorily protected from damage by abrasion, moisture, rust, or corrosion and shall be free of dirt, rust, oil, grease, or other deleterious substances when installed and when tensioned.

602-2.02 Ducts:

Duct enclosures for post-tensioning steel shall be rigid galvanized ferrous metal.

602-2.03 Grout:

Grout for post-tensioning tendons shall be a cement grout with a maximum water-cementitious material ratio of 0.45. Adding water to increase grout flowability that has decreased by delayed use of the grout will not be allowed. If approved by the Engineer, cement grout may contain chemical admixtures to improve workability and reduce the water required, reduce bleed, improve pumping properties or entrain air. Chemical admixtures shall conform to the requirements of Subsection 1006-2.04 of the specifications, except no admixtures containing chlorides, sulfates or nitrates shall be used.

Cement grout shall be stored per the manufacturer recommendations.

Portland cement shall be Type II conforming to the requirements of Subsection 1006-2.01 of the specifications.

Water shall conform to the requirements of Subsection 1006-2.02 of the specifications.

602-2.04 Structural Steel:

Material furnished for structural steel shall conform to the requirements of Section 1004 of the specifications.

602-2.05 Portland Cement Concrete:

Portland cement concrete shall conform to the requirements of Section 1006 of the specifications for the class and strength of concrete shown on the project plans.

602-3 Construction Requirements:

602-3.01 Shop Drawings:

(A) General:

Shop drawings of the proposed prestressed concrete items shall be submitted in accordance with the requirements of Subsection 105.03 of the specifications.

The drawings shall show the method and procedure of jacking and the type, size, and properties of the strands and number of strands. The size, shapes, dimensions, and concrete cover shall be shown for the reinforcing steel, including any reinforcing steel to be relocated or added.

Calculations shall be submitted showing the elongation of the strands at the time of jacking, the initial forces in the strands, and the final working forces. These calculations may be submitted separately from the drawings, and should also include the latest calibration certifications for the jacking system. In addition, a graph shall be prepared showing the gauge pressure in pounds per square inch and force in thousands of pounds plotted through the whole range of the tensioning calibration. Not more than two years shall have elapsed between any jack calibrations.

In addition to all required working drawings, the contractor shall prepare composite drawings in plan, elevation and section which show to scale the relative positions of all items that are to be embedded in the concrete and their embedment depth for the portions of the structure that are to be prestressed. Such embedded items include the prestressing ducts, vents, anchorage reinforcement and hardware, reinforcing steel, anchor bolts, earthquake restrainers, deck joint assemblies, drainage systems, utility conduits, and other such items. Such drawings shall be adequate to ensure that there is no conflict between the planned positions of any embedded items, and that concrete cover is adequate. If during the preparation of such drawings conflicts are discovered, the contractor shall revise its working drawing for one or more of the embedded items, or propose changes in the dimensions of the work as necessary to eliminate the conflicts or provide proper cover. Any such revisions shall be approved by the Engineer before work on an effected item is started.

The shop drawings reviewer shall notate their full first and last name and contact phone number on the approved shop drawings. The contractor shall submit a copy of the approved shop drawings to the Structural Materials Testing Section at least 5 working days in advance of the start of production of the precast items. Any changes to shop drawings must be approved by the Engineer. The updated and approved shop drawings shall be sent to the Structural Materials Testing Section at least 24 hours in advance of the start of production.

(B) Pretensioning Method:

The shop drawings shall show the strand locations and harping points of the strands.

The drawings shall identify the type of finish or surface condition on the top of the precast member.

The drawings shall include complete details of the method, materials, and equipment proposed for use in the prestressing operations. Such details shall outline the method and sequence of jacking, complete details of the prestressing steel, anchoring devices, type of enclosures, block-outs, and all other data pertaining to the post-tensioning system or operations.

(C) Post-Tensioning Method:

The drawings shall show the type, size, and properties of the strands or bars and the anchorage assemblies. The number of strands per tendon shall be shown. Details in addition to those shown on the contract plans shall be included for any additional reinforcing steel required to resist the concrete bursting stresses in the vicinity of the anchorage assemblies. The force or stress diagram shall be shown on the drawings. The sizes, shapes, dimensions, and concrete cover shall be shown for the ducts. Lay-out dimensions for locating the ducts along the tendon path shall not exceed 15-foot intervals. Vent locations and details of the vents shall also be included on the drawings.

Calculations shall be submitted showing the stresses in the anchorages and distribution plates.

The drawings shall include complete details of the method, materials, and equipment proposed for use in the tensioning operations. Such details shall outline the method and sequence of jacking, complete details of the prestressing steel, anchoring devices, type of enclosures, block-outs, and all other data pertaining to the post-tensioning system or operations.

602-3.02 Approval of Prestressing Systems:

The contractor is responsible for furnishing either basic or special anchorage devices which satisfy the anchor efficiency requirements of the latest edition of AASHTO LRFD Bridge Construction Specifications Article 10.3.2. The anchor efficiency test shall be conducted by an independent testing agency acceptable to the Engineer.

A basic anchorage device is an anchorage device meeting the restricted bearing compressive strength limits and the minimum plate stiffness requirements as specified in the latest edition of AASHTO LRFD Bridge Design Specifications Article 5.8.4.4.2. If basic anchorage devices are used, the contractor is responsible for the design of the anchorage device and for determining the required concrete strength.

A special anchorage device is an anchorage device whose adequacy must be proven experimentally in the standardized acceptance test and met the acceptance criteria specified in the latest edition of AASHTO LRFD Bridge Construction Specifications, Article 10.3.2.3. If special anchorage devices are used, the contractor is responsible for furnishing anchorage devices that satisfy the acceptance test requirements of the latest editions of AASHTO LRFD Bridge Design Specifications Article 5.8.4.4.3 and AASHTO LRFD Bridge Construction Specifications Article 10.3.2.3. This acceptance test shall be conducted by an independent testing agency acceptable to the Engineer. The contractor shall provide records of the acceptance test in conformance with the latest edition of AASHTO LRFD Bridge Construction Specifications Article 10.3.2.3.12 to the Engineer, and shall specify auxiliary and confining reinforcement, minimum edge distance, minimum anchor spacing, and minimum concrete strength at time of stressing required for proper performance of the local zone.

Post-tensioning systems which have been approved by the California Department of Transportation (Caltrans) and are listed in the Caltrans Authorized Materials List (AML) are considered an acceptable alternate to the AASHTO testing criteria. A copy of the approval letter from the Caltrans “Division of Engineers Services”, including any details associated with the approval, shall be submitted with the shop drawings by the post-tensioning company.

The contractor shall provide a calibration of the post-tensioning jacking system and shall provide the appropriate control settings for the Department's transducer, electro-hydraulic load cell system by testing the jacking system in a manner that has been pre-approved by the Engineer.

Any deviation from the approved materials and details will not be permitted unless new details are submitted by the contractor and approved in advance of use.

The approval of any proposed method, material or equipment shall not operate to relieve the contractor in any respect of full responsibility for successfully completing the prestressing in accordance with details shown on the project plans and the requirements of these specifications.

602-3.03 Sampling and Testing:

Sampling and testing shall conform to the requirements of AASHTO M 203, AASHTO M 204 and as specified herein.

Samples from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire, and from each lot of bar couplers to be used shall be furnished for testing. With each sample of prestressing steel wires, bars, or strands furnished for testing, there shall be submitted a Certificate of Compliance, conforming to the requirements of Subsection

106.05 of the specifications, stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

All materials for testing shall be furnished by the contractor at no additional cost to the Department. The contractor shall have no claim for additional compensation in the event work is delayed awaiting approval of the materials furnished for testing.

All bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the job site shall be assigned an individual lot number and shall be tagged in such a manner that each lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed at the job site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers recovered at the job site will be rejected.

602-3.04 Anchorage and Distribution for Post-Tensioned Structures:

All post-tensioned prestressing steel shall be secured at the ends by means of approved permanent type anchoring devices.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that effectively distributes the load to the concrete by meeting the requirements of a basic anchorage device or a special anchorage device.

Both basic and special anchorage devices must also meet the following anchor efficiency test criteria: the anchorage device shall hold the prestressing steel without exceeding anticipated set at a load producing a stress of not less than 95 percent of the guaranteed minimum tensile strength of the prestressing steel.

602-3.05 Duct Installation for Post-Tensioned Structures:

Duct enclosures for prestressing steel shall be mortar-tight and accurately placed at the locations shown on the project plans or approved by the Engineer.

Ducts shall be fabricated with either welded or interlocked seams. Galvanizing of the welded seam is not required. Ducts shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of duct shall be positive metallic connections which do not result in angle changes at the joints. Waterproof tape shall be used at all connections. Transition couplings connecting ducts to anchoring devices need not be galvanized.

All ducts or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

Ducts for prestressing steel shall be securely fastened in place to prevent movement and displacement during concreting. Ducts shall be placed within ± 1/4 inch of the dimensions shown on the approved shop drawings.

After installation in the forms, the ends of ducts shall be covered at all times as necessary to prevent the entry of water or debris. If prestressing steel is to be installed after the concrete has been placed, the contractor shall demonstrate to the satisfaction of the Engineer that the ducts are free of water and debris immediately prior to installation of the steel.

Prior to placing forms for closing slabs of box girder cells, the contractor shall demonstrate to the satisfaction of the Engineer that all ducts are unobstructed and if the prestressing reinforcement has been placed, that the steel is free and unbonded in the duct.

Prior to placing the forms for closing slabs of box girder cells, the contractor shall demonstrate to the Engineer, by aerostatic or hydrostatic tests, that the duct system does not permit leakage of grout into the box girder cells. For ducts completely encased in concrete, such tests shall be performed with a charging pressure of 40 pounds per square inch. Once the charging pressure is attained, the mechanical shut-off valve shall be closed for a period of not less than five minutes. A retained pressure of 20 pounds per square inch, or greater, after five minutes, will be considered an indication of acceptable performance.

Ducts not completely encased in concrete shall have the exposed areas sealed with an epoxy compound and then pressure tested to 20 pounds per square inch for five minutes. A retained pressure of 10 pounds per square inch or greater, after five minutes, will be considered an indication of acceptable performance.

All leaks shall be repaired and the ducts retested prior to placing the forms. If, after two attempts to repair leaks, the ducts still do not comply with the above performance requirements, the Engineer may accept the ducts if the Engineer is satisfied that no significant leakage of grout will occur. After completing each aerostatic or hydrostatic test, the ducts shall be blown dry with oil-free compressed air.

602-3.06 Prestressing:

(A) General:

Unless otherwise shown on the project plans, the stresses in the prestressing steel shall not exceed those specified in the current edition of the AASHTO LRFD Bridge Design Specifications. However, when low relaxation strands are used in post-tensioning cast-in-place concrete, the jacking force shall not exceed 78 percent of the minimum ultimate tensile strength of the prestressing steel.

Working force will be considered as the force remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, losses in prestressing steel due to sequence of stressing, friction, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

All prestressing steel shall be tensioned with hydraulic jacks so that the force in the prestressing steel shall not be less than the value shown on the project plans. Each jack used shall be equipped with either a pressure gauge or a load cell to determine the jacking force. All jacks and gauges shall be calibrated as a unit and shall be accompanied by a certified calibration chart.

All gauges shall be either a reading dial at least 6 inches in diameter or a digital display indicator. The increments shown on the reading dial gauge shall not exceed 2 percent of the jacking force. The digital display indicator shall be readable by normal vision at a distance greater than 10 feet. All gauges shall show a load accuracy of 1 percent of the load, from 1 percent to 100 percent of the capacity of the gauge.

The certified calibration charts for the hydraulic jacks and pressure gauges may be checked before and during jacking operations with Department-furnished load cells. If the certified calibration is found to be in error, the operation shall be immediately discontinued until a new certified calibration is performed by the contractor.

Welding or a welding ground shall not be done near prestressing steel and ducts. Welding near prestressed work shall be done only if specified on the project plans or directed by the Engineer.

The tensioning process shall be so conducted that the force being applied and the elongation of the prestressing steel may be measured at all times. The actual elongation obtained from the calibrated force value shall be compared with the theoretical calculated elongation. If the actual measured elongation differs by more than 5 percent of the theoretical calculated elongation, the entire operation shall be carefully checked and the source of the error determined and corrected before proceeding with the tensioning. A record of the prestressing force and elongations shall be kept at all times and submitted to the Engineer for approval.

(B) Pretensioning Precast Concrete:

The tensioning force in pretensioned strands shall not be transferred to the member until tests on cylinder specimens made and cured under the same conditions as the member indicates the required compressive release strength has been attained. This shall constitute the end of the curing period.

The release of the strands shall be from one or both ends of the casting bed depending upon which method produces the least movement of items in the casting bed and the least horizontal eccentricity of the initial prestressing force in the member.

All pretensioned items shall be tensioned either by single strand or multiple strand jacks. Stressing gauges, jacks, and other related equipment shall be calibrated annually or more frequently if necessary. The manufacturer shall supply calibration reports when requested by the Department.

No more than one splice chuck shall be used on a cable strand. Splice chucks will not be allowed within the member. Strands to be spliced shall have the same lay or direction of twist. When multiple cable tensioning is employed, the use of splice chucks shall be limited to 10 percent of the cable strand to be tensioned or all cable strands to be tensioned.

Each plant shall be required to supply load cells to measure force on each production bed as directed by the Engineer. This may include load cells placed on cable strand between chucks and the dead men (anchorage bulkheads) on both straight and harped strands, at both the live and dead ends. Load cells shall be used as necessary to monitor the gauge pressure during stressing operations, abutment rotation, and bed shortening. Load cells shall be calibrated annually or more frequently if necessary.

If loss of force is suspected, load cells shall be placed between the stressing chucks and the anchorage on an everyday basis to verify stressing forces for each production bed. When all losses have been verified for each production bed and stressing values are within tolerances, load cells shall be used daily as needed to monitor stressing forces of each stressing jack. Periodically, load cells shall be placed between strand chucks and anchorage as verification.

All cable strands shall be placed within 1/4 inch of the strand locations indicated on the approved shop drawings. All hold downs and cable locations shall be clearly marked on the approved drawings.

At no time shall a cable strand which has been previously stressed and used outside a Precast/Prestress product or member be used at a later time within another Precast/Prestress member. Cable strand shall be free of deleterious materials such as release agents, oils, grease, dirt, mud, or other foreign matters. Any cable found in such condition shall be cleaned or removed, based on the inspector’s observations.

Jacking the prestressing steel shall be performed in two increments. An initial tension shall be applied to the strands to straighten them, to eliminate slack and provide a starting or reference point for measuring elongation. The final tension shall then be applied and elongation of strands measured. Elongations shall be measured to the nearest 1/8 inch.

No more than one broken wire will be permitted in a single strand.

Anchoring devices shall be capable of holding strands with a minimum of differential slippage. Stringing of following lengths of strand incorporating points previously gripped within lengths to be stressed will not be permitted. Any rotation of the strand shall be limited to not more than one revolution per 100 feet of exposed strand.

Harped strand shall be tensioned from both the live and dead ends, except for the following:

(1) If one member is to be produced;

(2) If multiple strand tensioning is used and cables are vertically displaced into the correct height. Load cells shall be used to verify the force; and

(3) If load cell verifies force after stressing from the live end.

At no time shall stressing operations exceed 80 percent of the minimum ultimate tensile strength for the cable strand as listed in the approved shop drawings.

Initial stressing force shall not exceed 25 percent of the final force.

De-tensioning of cables shall not be performed until concrete test cylinders indicate release strength has been attained. De-tensioning shall be performed in a manner that keeps the prestressing forces nearly symmetrical about the vertical axis of the product and:

(1) Minimizes shock to the member;

(2) Minimizes movement against restrained items such as forms, inserts and hold downs;

(3) Prevents overstressing or damaging items;

(4) Prevents shock and thermo-cracking that may be caused by using accelerated curing such as steam or radiant heat; and

(5) De-tensioning shall be performed immediately after curing and the removal of forms, curing blankets, tarps, or plastic coverings while the concrete is warm and moist.

When ordered by the Engineer, prestressing strands in precast items, if tensioned individually, shall be checked by the contractor for loss of force not more than 3 hours prior to placing concrete for the items. The method and equipment for checking the loss of force shall be subject to

approval by the Engineer. All strands which show a loss of prestress in excess of 3 percent shall be retensioned to the original jacking force.

When concrete has not been placed within 72 hours of the tensioning of the prestressing strands, retensioning of all strands will be required prior to placing of the concrete.

(C) Post-Tensioning Cast-in-Place Concrete:

Prestressing steel for post-tensioning, which is installed in structures prior to placing and curing of the concrete, shall be continuously protected against rust or other corrosion until grouted by means of an approved corrosion inhibitor placed in the ducts or applied to the steel in the duct. If the strands are in the duct at the time concrete is placed, no tensioning will be allowed until it is demonstrated to the satisfaction of the Engineer that the prestressing strands are free and unbonded in the duct.

When prestressing steel for post-tensioning is installed in the ducts after completion of concrete curing, and if stressing and grouting are completed within 10 days after the installation of the prestressing steel, rust which may form during the 10 days will not be cause for rejection of the steel.

Except as herein provided, cast-in-place concrete shall not be prestressed until at least seven days after the last concrete has been placed in the structure to be prestressed and until the compressive strength of all placed concrete, has reached the required strength for jacking.

Prestressing steel shall be tensioned by jacking from each end of the tendon for continuous structures unless otherwise noted on the project plans. Such jacking of both ends need not be done simultaneously, unless specifically indicated on the plans or in the Special Provisions.

Prestressing steel may be tensioned by jacking from one end only for simple span structures.

Should the contractor elect to furnish an anchoring device of a type which is sufficiently large and which is used in conjunction with a steel grillage embedded in the concrete that effectively distributes the compressive stresses to the concrete, the steel distribution plates or assemblies may be omitted.

Where the end of a post-tensioned assembly is not covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices are at least 2 inches inside of the end surface of the items, unless a greater embedment is shown on the project plans. Following post-tensioning, the recesses shall be filled with concrete for the structure and finished flush.

At no time will a cutting torch be allowed for cutting prestressing steel for cast-in-place prestressed structures.

602-3.07 Grouting of Post-Tensioned Members:

Post-tensioned prestressing steel shall be bonded to the concrete by completely filling the entire void space between the duct and the tendon with grout.

All of the tendons in a cast-in-place concrete structure shall have been fully tensioned and anchored prior to any grouting operation.

The grout shall be mixed in mechanical mixing equipment of a type that produces uniform and thoroughly mixed grout. Water shall be first added to the mixer followed by cement. Retempering of grout will not be permitted. All grout shall pass through a screen with 1/8-inch maximum clear openings prior to being placed in the grouting equipment and shall be continuously agitated until it is pumped.

The quality of the grout shall be determined by the Engineer in accordance with the requirements of Arizona Test Method 311. The efflux time of a grout sample immediately after mixing shall be not less than 11 seconds.

The maximum temperature of the grout shall be 90 degrees F and the minimum 50 degrees F.

Grouting equipment shall be capable of grouting at a pressure of at least 150 pounds per square inch and shall be furnished with a pressure gauge having a full-scale reading of not more than 300 pounds per square inch. Maximum grouting pressure shall not exceed 250 pounds per square inch.

Standby flushing equipment capable of developing a pumping pressure of 250 pounds per square inch and of sufficient capacity to flush out any partially grouted ducts shall be provided and available at the job site. Equipment capable of providing dry, oil free compressed air for removing water from the ducts shall also be available at the site.

All ducts shall be clean and free of deleterious materials that would impair bonding of the grout or interfere with grouting procedures. Compressed air used to blow through the ducts shall be oil-free and water-free. Immediately prior to grouting, the contractor shall check all inlet and outlet pipes to verify they are capable of accepting grout injection.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Ejection pipes shall be fitted with valves capable of withstanding the pumping pressures. Valves shall not be removed or opened until the day following the grouting operation, unless otherwise approved by the Engineer. Draped tendons exceeding 400 feet shall be vented at all high

points. Grout vents shall be made of rigid tubing or pipe with threaded fittings and shutoff valves.

Grout shall be injected at the low end of the duct and continuously wasted at the outlet until no visible slugs of water or air are ejected. The outlet pipe shall then be closed and the duct shall then be pressurized. The pressurized duct shall maintain a minimum pressure of 75 pounds per square inch for a minimum time of one minute. The valve at the inlet shall then be closed while maintaining this minimum pressure.

If complete grouting of the duct cannot be achieved or the grouting operation is interrupted, the contractor shall flush the grout out of the duct immediately with water.

When hot weather conditions would contribute to quick stiffening of the grout, the grout shall be cooled by approved methods as necessary to prevent blockages during pumping operations. The use of an approved chemical admixture should also be considered for increasing the pumping efficiency and/or time of set.

When freezing weather conditions are anticipated during and following the placement of grout, the contractor shall provide adequate means to protect the grout in the ducts from damage by freezing.

Vibration from contractor controlled equipment shall be eliminated within 100 feet during grouting and for a period of 24 hours after grouting.

The surfaces of concrete against which concrete encasement over anchorage assemblies is to be placed shall be abrasive blast cleaned and aggregate exposed after grouting of the ducts has been completed.

602-3.08 Finishing Precast Concrete:

The finishing of precast concrete bridge structures shall comply with the requirements of Subsection 601-3.05 of the specifications. In addition, those exterior surfaces of exterior bridge structures normally in the view of vehicular or pedestrian traffic shall be finished in accordance with the requirements for a Class II Finish.

Unless otherwise specified on the plans, the top surface of I-beams, box beams, and flat slabs shall be roughened with a hand tine rake while the concrete is still plastic.

All projecting strands that are not scheduled to remain for future embedment shall be cut off at the surface of the concrete. Strands that are to remain shall be cut and bent to the dimensions shown on the plans. If the end of the precast bridge member is not embedded in cast-in-place concrete, then all the strands shall be cut or ground flush with the surface of the concrete and thoroughly coated with a bitumastic type sealant.

Exposed uncoated reinforcing bars and strand shall be cleaned of concrete laitance and other foreign materials. If concrete laitance is allowed to harden and other foreign materials are allowed to remain on the bars, then abrasive blast methods shall be conducted for cleaning. The cleaning of exposed epoxy-coated reinforcing steel shall be limited to methods not damaging to the coating, the actual cleaning to be completed while the concrete laitance are still plastic. Any damage done to the epoxy coating shall be repaired in accordance with Subsection 605-3.03(B) of the specifications.

The work described in this subsection shall be accomplished in the production yard of the precast manufacturer. Precast bridge structures will be approved for transportation based on the following criteria; the member has been inspected and approved by the Department, a minimum of 14 days have passed since concrete placement, and the 28-day compressive strength requirement has been met.

602-4 Method of Measurement:

No measurement or direct payment will be made for prestressing precast concrete, the cost being considered as included in the cost of precast concrete items.

Prestressing concrete in cast-in-place structures will be measured by the approximate station for which a lump sum item is listed in the bidding schedule for such work.

602-5 Basis of Payment:

Prestressing cast-in-place concrete will be paid at the contract lump sum price, complete in place.

Furnishing and placing reinforcement not shown on the project plans and required only for anchorage zone recesses, blocks, duct ties, and grillage assemblies, as recommended by the post-tensioning system used, shall be considered as included in the lump sum price paid for prestressing cast-in-place concrete.

Furnishing and placing concrete used in girder web flares and for concrete used in external anchorage blocks, including cover of distribution plates, shall be considered as included in the contract lump sum price paid for prestressing cast-in-place concrete.

Partial payments may be made in accordance with the provisions of Subsection 109.07 of the specifications.

Payments will be made on the basis of the following:

(A) Installation of Ducts: 25 Percent of Contract Lump Sum

(B) Installation of Tendons: 50 Percent of Contract Lump Sum

(C) Completion of Tensioning: 15 Percent of Contract Lump Sum

(D) Completion of Grouting: 10 Percent of Contract Lump Sum

SECTION 603 PILING:

603-1 Description:

The work under this section shall consist of the furnishing and driving piles at the locations and in accordance with the details shown on the plans and in accordance with the requirements of these specifications.

Piling shall consist of steel piles, cast-in-place concrete piles, precast concrete piles, and timber piles and shall be of the kinds, sizes, and lengths shown on the project plans.

When load test piles are shown on the project plans, pile loading tests shall be performed on said test piles in accordance with the requirements of the Special Provisions and as directed by the Engineer.

603-2 Materials:

603-2.01 Steel Piles:

Steel piles shall be of the section shown on the project plans and shall be structural steel conforming to the requirements of AASHTO M 183.

Pile points, when specified on the project plans or ordered by the Engineer, shall be cast steel and be specially manufactured for hard pile driving.

603-2.02 Cast-in-Place Concrete Piles:

Cast-in-place concrete piles shall consist of steel shells driven permanently to the required bearing value and penetration and filled with concrete.

Concrete for filling cast-in-place concrete piles shall be Class S Portland cement concrete of the compressive strength shown on the plans and shall conform to the requirements of Section 1006 of the specifications.

Steel shells shall be of the diameter, thickness, length, and design shown on the project plans. The shells shall be of sufficient strength and rigidity to permit driving and to prevent distortion caused by soil pressures or the driving of adjacent piles. The shells shall also be

sufficiently watertight to exclude water during the placing of the concrete.

Unless otherwise shown on the plans or ordered by the Engineer, steel shells shall be equipped with closed driving tips. Driving tips shall be not more than 1/2 inch greater in diameter than the diameter of the shell at the tip. Closed driving tips may consist of flat steel plates of sufficient strength to suit pile driving conditions or may be cast steel points suitable for driving conditions. The use of wedge tips constructed of flat steel plates will not be permitted.

Reinforcing steel shall be as shown on the project plans and shall conform to the provisions of Section 1003 of the specifications.

603-2.03 Precast Concrete Piles:

Precast concrete piles shall be either conventionally reinforced concrete piles or precast prestressed piles with prestressed steel strands.

Concrete shall be Class S concrete of the compressive strength shown on the plans and shall conform to the requirements of Section 1006 of the specifications.

Precast concrete piles shall be constructed in accordance with the details shown on the plans and in accordance with the requirements of Section 601 of the specifications. Prestressing shall be in accordance with the requirements of Section 602 of the specifications using the pretensioning method.

Steel reinforcement shall conform to the requirements of Section 1003 of the specifications.

Precast concrete piles shall be fabricated on casting beds founded on permanent concrete foundations using steel forms, unless otherwise approved by the Engineer. Outer forms shall enclose all except the top horizontal surface of the pile. The side forms may have a maximum draft on each side not exceeding 1/4 inch per foot. All corners shall be chamfered 2 inches or rounded to a 2-inch radius.

Forms for piles shall be such as to avoid the formation of fins at the intersection of the surfaces. The top of the concrete casting shall be given a uniformly smooth finish to match the finish surface at the formed sides.

Pile ends shall have plane surfaces and be perpendicular to the longitudinal axis of the pile. The maximum sweep (deviation from straightness measured along two perpendicular faces of the pile while not subject to bending forces) shall not exceed 1/8 inch in any 10 feet of its length, 3/8 inch in any 40 feet, or 3/16 inch times total length in feet divided by 20 feet.

Pick-up points for piles shall be plainly marked on all piles after removal of the forms, unless special lifting devices are attached for pick-up and all lifting shall be done at these points.

The use of special embedded or attached lifting devices, the employment of other pick-up points or any other method of pick-up shall be subject to written approval by the Engineer.

603-2.04 Timber Piles:

All timber piles shall conform to the requirements of ASTM D25. Treated timber piles shall be either Southern yellow pine, Ponderosa pine, Douglas fir or Larch. All piles for permanent structures shall be cleaned.

Timber piles requiring treatment shall be pressure treated in accordance with the requirements of AASHTO M 133.

Treated piles will be inspected for grade and quality before treatment and each piece accepted for treatment will be hammer-marked on the butt end with the registered brand of the inspector.

603-2.05 Paint:

Paint for steel piles or metal shells shall be of the type shown on the project plans and shall conform to the requirements of Section 1002 of the specifications.

603-2.06 Certificates:

Certificates of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be furnished for all steel piling and steel shells used.

603-3 Construction Requirements:

603-3.01 General:

When the project plans or specifications permit the use of more than one type of pile, the same type of pile shall be used for all piles within each individual footing, unless otherwise permitted by the Engineer. The contractor shall be responsible for furnishing piling of sufficient length to obtain the penetration and bearing value required.

603-3.02 Predrilled Holes:

Piles to be driven through embankment constructed by the contractor shall be driven in holes drilled or spudded through the embankment when shown on the project plans or ordered by the Engineer. The hole shall have a diameter of not less than the greatest dimension of the pile cross section plus 6 inches. After driving the pile, the space around the pile

shall be filled to ground surface with dry sand or pea gravel or as specified on the plans.

603-3.03 Equipment:

(A) General:

Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturer of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of steam, air, or diesel hammers shall be maintained in first class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient steam, air, or diesel hammers shall not be used.

(B) Hammers for Steel Piles:

Steel piles shall be driven with a steam or air or diesel hammer which shall develop an energy per blow of not less than 15,000 foot-pounds unless otherwise specified on the project plans.

(C) Hammers for Metal Shells:

Metal shells for cast-in-place concrete piles shall be driven with a steam or air or diesel hammer. For shells driven with the aid of a mandrel, the combined weight of the shell and the mandrel shall be considered as the weight of the pile. The hammer shall develop an energy per blow of not less than one foot-pound for each pound of weight driven. In no case shall the total energy developed by the hammer be less than 10,000 foot-pounds per blow for driving shells with a mandrel. Hammers used to drive metal shells without a mandrel shall develop an energy per blow of not less than 15,000 foot-pounds.

(D) Hammers for Timber Piles:

Drop hammers may be used for timber piles and shall weigh not less than 3,000 pounds and shall be equipped with efficient leads and hoisting equipment. The fall of the hammer shall not exceed 12 feet.

(E) Leads:

Pile driver leads shall be constructed in such a manner as to afford freedom of movement to the hammer and they shall be blocked or braced so that the initial driving of the pile can be done without rotation or shifting of the pile and to assure concentric hits on the piles.

(F) Followers:

Driving of piles with followers will not be permitted.

603-3.04 Driving Piles:

(A) General:

All piles shall be driven to a minimum bearing value or to a required tip elevation or a combination of both, as follows:

Where a minimum bearing value is specified, all piles shall be driven to a bearing value not less than that specified, regardless of tip elevation. Where a required tip elevation is specified and no bearing value is specified, all piles shall be driven to at least the required tip elevation using a hammer that is capable of overcoming the soil resistance to reach that elevation without causing damage to the pile. Where a minimum bearing value and a required tip elevation are both specified, the piles shall be driven to a bearing value not less than that specified and, in addition, if the required tip elevation has not been attained, shall be driven further to the required tip elevation. The required tip elevation shall be the estimated tip elevation shown on the project plans or the adjusted elevation when allowed by the project plans for increased bearing value.

Piles shall not be driven until after the excavation or embankment in the area of the piling is complete. Any material forced up between the piles shall be removed to correct elevation without cost to the Department before concrete for the foundation is placed.

Piles shall be accurately spaced and shall be driven either vertically or to the batter shown on the project plans. For trestle work and for piles which extend above ground in the completed structure, care shall be exercised to obtain proper alignment. Piles materially out of line shall be pulled and redriven or additional piles shall be driven as directed. Piles which are to be capped shall be accurately cut off so that true bearing is obtained on all piles without the use of shims. Piles cut off otherwise shall be replaced.

Insofar as practicable, the driving of individual piles shall be a continuous operation.

(B) Driving Steel Piles:

The heads of steel piles shall be cut squarely and a cast or structural steel driving head or cap shall be used to hold the axis of the pile in line with the axis of the hammer and to prevent excessive upsetting of the pile head under extremely hard driving conditions.

(C) Driving Metal Shells:

An approved driving head, as furnished by the manufacturer or equal, which shall be of proper size and design for the particular size and type of hammer to be used, shall be provided to distribute properly the hammer blows and to prevent damage to the shell while driving.

The contractor shall have available at all times a suitable light, of an approved type, for thoroughly illuminating the interior of the pile shells for their entire length after being driven. Any shell that shows bends, kinks or other deformations incurred during the process of driving that would impair the strength or efficiency of the completed pile shall be replaced as directed by the Engineer and at the expense of the contractor. After all the shells have been driven to proper alignment, spacing and elevation and cut off at the required elevation, they shall be given a final inspection before they are filled with concrete. Any water or other foreign substance found in them shall be removed. Any required reinforcing steel shall be placed into the shell and supported and blocked to hold it in position during the concreting operation.

Upon approval, the shells shall be filled with concrete in the presence of the Engineer. The concrete shall be placed in layers and vibrated in accordance with the requirements of Subsection 601-3.03 of the specifications.

(D) Driving Timber Piles:

Long piles shall be adequately supported against lateral buckling during the driving process.

All timber piles shall have square recut heads and tips and when necessary, the heads shall be accurately shaped or chamfered to take rings or head blocks.

Collars, bands, or other devices shall be provided where necessary to prevent splitting or brooming of the timber piles. Tips shall be properly formed to take shoes if, in the judgment of the Engineer, shoes are found necessary. They shall be furnished and attached to the piles by the contractor as directed. The contractor shall do all work necessary or incidental to the furnishing and proper fitting and fastening of said shoes to the piles and any other work necessary in driving the piles.

Treated timber piles shall be carefully handled so that the outer fibers are not broken or unduly injured. Treated piles which have been roughly handled in shipment or driving will be rejected. All treated piles shall be handled by fiber rope slings or other means which will not break the outer fibers. The use of peavies, cant hooks, or other sharp tools will not be allowed.

The heads or butts of all treated timber piles, except those to be encased in concrete, shall be treated. After the piles have been driven and cut off to the proper elevation for the cross cap, the sawed surface shall be either covered with three applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or the surface shall be thoroughly brush coated with three applications of hot creosote oil and covered with hot roofing pitch. A covering of No. 24 gauge galvanized steel 6 inches in diameter larger than the diameter of the pile shall then be placed on the pile head and bent down over the sides of the pile to shed water.

(E) Driving Precast Concrete Piles:

The heads of concrete piles shall be protected from direct impact of the hammer by a cushion driving block. The cushion shall be maintained in good condition during the entire driving operation.

(F) Defective Piles:

The methods used in driving piles shall not subject them to excessive and undue abuse producing crushing and spalling of concrete, injurious splitting, splintering, and brooming of the wood, or deformation of the steel. Manipulation of piles to force them into proper position, if considered by the Engineer to be excessive, will not be permitted.

A concrete pile will be considered defective if it has a visible crack, or cracks, extending around the entire periphery of the pile, or any defect which, as determined by the Engineer, affects the strength or life of the pile.

Defective or damaged piles, piles which are driven materially out of position or timber piles which have been cut too short will be rejected. Rejected piles and any falsework piles shall be removed or cut at least 2 feet below the final ground surface, except that rejected piles which will interfere with the work shall be removed. Rejected shell piles which are left in place shall be filled with utility concrete conforming to the requirements of Section 922 of the specifications.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again.

603-3.05 Pile Splices:

Timber piles shall not be spliced, except upon written permission of the Engineer, in which case the method of splicing shall be in accordance with a working drawing submitted by the contractor to the Engineer for approval.

Metal shells and steel piles shall be spliced in accordance with the details shown on the plans. The indiscriminate splicing of steel piles will not be allowed.

Splicing of metal shells and steel piles shall be accomplished only by welders who have been prequalified and certified for the type of weld required.

Precast concrete piles shall not be spliced but instead shall be extended by casting a further length on top of the pile in accordance with the details shown on the project plans. Precast piles shall not be extended unless specified on the project plans or authorized in writing by the Engineer. If further driving is required, it shall not be done until the concrete has reached its 28-day strength.

In any case where the project plans do not show details of a splicing method, splices shall not be made until the Engineer has approved the method proposed by the contractor.

603-3.06 Pile Cutoff:

After driving has been completed, all piles shall be cut at the elevation determined by the Engineer. Cut-off material determined to be worth salvaging shall be stockpiled at an accessible and approved location on the site for removal by Department forces. Material determined to be unsatisfactory for salvaging shall be removed from the site and disposed of by the contractor. Steel piles and steel shells which are less than 5 feet in length will be considered unsatisfactory for salvage and shall become the property of the contractor.

Each pile shall be cut on a plane normal to its axis. Embedment and anchorage into concrete caps or footings shall be provided as shown on the project plans.

Unless otherwise shown on the project plans, precast concrete piles shall be trimmed off to 3 inches above the bottom of the cap or footing and the edges beveled. Vertical reinforcement shall be cut off to provide 18 inches of embedment, and prestressing strands shall be cut off to provide 24 inches of embedment into the cap or footing. Any concrete damaged below cut-off elevation in the driving or cutting shall be removed to solid material and the pile built back up to elevation as specified under Subsection 603-3.04 of the specifications.

603-3.07 Painting Metal Piles:

When steel piles or metal shells for cast-in-place concrete piles are driven and portions of these piles either extend above the ground or above the water surface, all surface thereof that will be exposed in the completed work shall be protected by three coats of paint. The protection shall extend from an elevation 2 feet below the ground surface or 2 feet below low water level when the piles are in water, to the top of the exposed portion of the pile.

Painting of piles shall be in accordance with the requirements of Section 610 of the specifications.

603-3.08 Determination of Bearing Values:

The bearing value of each pile that is driven by a hammer shall be measured by the driving formula as specified herein. The contractor shall provide facilities and cooperation to the Engineer as needed to obtain the data required for this purpose.

TABLE 603-1		
Type of Pile	**Type of Hammer**	**Formula**
Timber and Steel	Drop	$P = \frac{2FH}{S+1.0}$
Metal Shells for Cast-In-Place Concrete, Timber, and Steel	Single-Acting Power	$P = \frac{2FH}{S+0.1}$
	Double-Acting Power (Use either formula)	$P = \frac{2H(F+Ap)}{S+0.1}$ $P = \frac{2E}{S+0.1}$
Notes: P =safe allowable bearing value of piles, in pounds. F =force of striking parts of the hammer, in pounds. H =fall of hammer, in feet. S =average penetration, in inches per blow, for the last five to 10 blows for drop hammers, and the last 10 to 20 blows for steam or air and diesel hammers. A =effective area of piston, in square inches. p =mean effective steam or air pressure, in pounds per square inch. E =manufacturer's rating of energy developed by the hammer, in foot-pounds per blow.		

The formulas in Table 603-1 are applicable only when:

(A) The hammer has a free fall, except for double-acting hammers;

(B) The head of the pile is not broomed or crushed;

(C) The penetration is reasonably uniform; and

(D) There is no appreciable bounce after the blow. If there is an observable bounce, the value of H shall be reduced by twice the bounce height.

603-4 Method of Measurement:

603-4.01 Furnishing Piles:

Furnishing piles will be measured to the nearest linear foot of piles furnished in accordance with the lengths specified on the project plans or ordered by the Engineer, except that no measurement for payment will be made for furnishing piles which are subsequently damaged in handling or driving to the extent that they are unusable.

603-4.02 Driving Piles:

Driving piles will be measured to the nearest linear foot from the tip to the required cut-off point of all piles satisfactorily driven.

603-4.03 Splicing Piles:

Splicing piles will be measured as a unit for each splice made, when splicing is required because of pile lengths driven in excess of those specified on the project plans or ordered by the Engineer.

No measurement for payment will be made of splices made to obtain pile lengths in accordance with the details shown on the project plans or ordered by the Engineer.

603-5 Basis of Payment:

603-5.01 General:

The accepted quantities of each of the items of work listed on the bidding schedule, measured as provided above, will be paid for at the contract unit price, as follows: When more than one type of piling is shown, each type will be listed on the bidding schedule and paid for separately.

603-5.02 Furnishing Piles:

The contract price for furnishing piles shall include full compensation for furnishing precast concrete piles, steel piles, pile points or shoes, metal shells or pipe casings (for cast-in-place concrete piles), or timber piles delivered to the site of the work, in the quantities, types, and sizes specified and lengths specified or ordered, in a condition ready to be driven.

Furnishing, fitting, and fastening metal shoes for timber piles will be paid for in accordance with the requirements of Subsection 104.02 of the specifications.

603-5.03 Driving Piles:

The contract price for driving piles shall include full compensation for placing piles and metal shells or pipe casings and driving them at the locations specified and to the required bearing value and tip elevation; furnishing and placing Portland cement concrete and reinforcing steel in metal shells for cast-in-place concrete piles; for cutting piles off and furnishing and installing anchoring devices; and for painting piling as required.

The contract price for driving piles shall also include full compensation for jetting, drilling, blasting or other similar work as necessary to obtain the required tip elevation and furnishing and attaching brackets, lugs,

core stoppers, or other similar devices to increase the bearing value of the piles, when such work or materials is specified on the project plans or in the Special Provisions.

When the work and materials described in the preceding paragraph are not specified on the project plans, but the Engineer determines, or it has been demonstrated to the Engineer's satisfaction, that the required tip elevation cannot be reached without jetting, drilling, blasting, or other similar work, or that the required bearing value cannot be obtained without the use of brackets, lugs, core stoppers, or other similar devices, the Engineer will order such work to be performed and such materials to be furnished as the Engineer considers necessary under the conditions encountered in order that the required tip elevation or bearing value may be obtained. Materials and labor necessary to accomplish the requirements will be paid for in accordance with the provisions of Subsection 104.02 of the specifications.

603-5.04 Splicing Piles:

The contract price for splicing piles shall include full compensation for furnishing all materials and labor and splicing piles in accordance with the specifications and the details shown on the project plans.

Payment for splicing piles will be made at the contract unit price per splice determined by multiplying the contract unit price per linear foot for furnishing the pile by a factor of five.

The total quantity of splicing piles necessary to complete the work may vary considerably from the quantity shown in the bidding schedule; however, no adjustment in the contract unit price due to an increase or decrease in quantity, as provided for in Subsection 104.02 of the specifications, will be made for this contract item.

SECTION 604 STEEL STRUCTURES:

604-1 Description:

The work under this section shall consist of constructing steel structures in accordance with the details shown on the plans and the requirements of these specifications. The work shall include furnishing, fabricating, erecting, and painting the structural steel and other metals and performing all work required to complete the bridge structures and other structures.

604-2 Materials:

604-2.01 Structural Steel:

Structural steel shall conform to the requirements of ASTM A36, unless otherwise specified or shown on the plans.

All rolled section girders or structural steel plate used for the fabrication of tension flanges, web plates, eyebars and hanger plates and for splice plates of tension flanges and eyebars shall meet the longitudinal Charpy V-notch impact value requirements specified herein. Sampling procedures shall conform to the provisions in ASTM A673. The H (Heat) frequency of testing shall be used for structural steels conforming to ASTM A36, A572 and A588. The P (Piece) frequency of testing shall be used for structural steel conforming to ASTM A514. Charpy V-notch impact values shall be determined in accordance with ASTM E23.

Charpy V-notch (CVN) impact values shall conform to the following minimum values:

Material		Impact Value: (foot-pounds at Temp. °F)
ASTM A36		15 at 40 °F
ASTM A572*		15 at 40 °F
ASTM A588*	2 inches and under	15 at 40 °F
ASTM A588*	Over 2 to 4 inches	20 at 40 °F
ASTM A514	2-1/2 inches and under	25 at 0 °F
ASTM A514	Over 2-1/2 to 4 inches	35 at 0 °F

Note:

*If yield point of material exceeds 65,000 psi, the temperature for CVN impact value for acceptability shall be reduced 15 °F for each increment of 10,000 psi above 65,000 psi.

604-2.02 Steel Structural Rivets:

Steel structural rivets shall conform to the requirements of ASTM A502.

604-2.03 High-Strength Bolts, Nuts and Washers:

High Strength Bolts shall conform to ASTM F3125 Grade A325 except as may be modified herein.

The maximum hardness for ASTM F3125 Grade A325 bolts shall be 33 HRC for diameters 1 inch and smaller, and 30 HRC for diameters greater than 1 inch.

Nuts and washers, appropriate to the type of high strength bolt to be used, shall conform to ASTM A563 or A194, for nuts, and F436, for washers, respectively.

Nuts shall be Grade 2H or DH for black or galvanized bolts. For galvanized bolts the nuts shall be over tapped to the minimum amount required for the bolt assembly.

All nuts, bolts, and washers shall have the manufacturers' markings on them.

(A) Certificate of Analysis:

Each lot of bolts, nuts, or washers shall be accompanied by a Certificate of Analysis.

The Certificate of Analysis shall provide a lot number corresponding to that appearing on the shipping package. The certification shall note when and where all testing was done, including the rotational-capacity tests indicated herein, and shall include zinc thickness when galvanized bolts and nuts are used.

Testing to be included in the Certificate of Analysis shall be done according to the "shipping lot" method. The minimum testing required is as follows:

(1) Rotational-Capacity Test:

High-strength bolts, both black and galvanized, shall be subjected to a rotational-capacity test (ASTM A325, Section 6.2) and shall meet the following requirements when tested by the manufacturer:

(a) The tested bolts shall go through two-times the required number of turns (from snug tight conditions) indicated in the AASHTO Bridge Specification, Table 11.5B, in a Skidmore-Wilhelm Calibrator, or equivalent tension measuring device, without stripping or failure;

(b) During this test, the maximum recorded tension shall be equal to or greater than 1.15 times the Required Fastener Tension, as specified in AASHTO Table 11.5A; and

(c) The measured torque to produce the Required Fastener Tension shall not exceed the value obtained by the following equation:

$$Torque = 0.25\ PD$$

Where: Torque =Measured Torque, in foot-pounds

P =Measured Bolt Tension, in pounds

D =Diameter, in feet

(2) Proof Load Tests:

Proof load tests, performed by the manufacturer, are required for the bolts (ASTM A325) and for the nuts (ASTM A563 or A194). The proof load tests for nuts to be used with galvanized bolts shall be performed after galvanizing, over tapping and lubricating.

(B) Acceptance Testing:

High-strength bolts, nuts and washers will be field sampled at random by the Engineer, according to the "shipping lot" method, upon receipt of the bolt shipment by the contractor. A minimum of three bolts, with corresponding nuts and washers, or 0.1 percent of the lot, for lots in excess of 3,000, will be sampled for acceptance testing, for each bolt diameter. Samples will be submitted to ADOT Materials Group or a designated testing laboratory for the following tests:

(1) Wedge Test:

Bolts shall be tested in accordance with ASTM F606, Section 3.5. Fracture shall be in the body or threads of the bolt without any fracture at the junction of the head and body.

(2) Rockwell Hardness:

Rockwell hardness shall be determined in accordance with ASTM E18 within the specified maximum shown above for bolts. Nuts and washers will only be tested for Rockwell hardness, in accordance with ASTM E18, to confirm compliance with ASTM A563 or A194 for nuts and F436 for washers.

If any of the test bolts fail either of the above acceptance tests, the entire lot which it represents will be rejected. Similarly, if any of the nuts or washers fail the Rockwell Hardness Test, the entire lot of nuts or washers will be rejected.

(C) Installation:

All galvanized nuts shall be lubricated with a lubricant containing a visible dye so that a visual check can be made for the lubricant at the time of field installation. Black bolts must be "oily" to the touch when installed. Weathered or rusted bolts shall be cleaned and re-lubricated prior to installation.

Installation of all-high strength bolts shall be in accordance with paragraph 11.5.6.4, "Installation," of the AASHTO Bridge Specifications. Of particular importance is obtaining the "snug tight" condition as defined in paragraph 11.5.6.4.4 for any method of final tightening.

A Skidmore-Wilhelm Calibrator or other acceptable bolt tension indicating device will be provided by the Department at each job site for use during bolt installation. Periodic tests (daily when calibrated wrench tightening is used) will be performed by the Department to ensure the as-installed bolt/nut/washer assembly meets the above requirements. [For short grip bolts, direct tension indicators (DTI) with solid plates may be used to perform this test. The DTI shall be checked with a longer grip bolt in the Skidmore-Wilhelm Calibrator first].

The cost of furnishing test bolts, nuts and washers will not be directly reimbursed, but will be considered included in the cost of related contract items.

Suitable nuts shall conform to the requirements of ASTM A563 and suitable hardened washers shall conform to the requirements of ASTM F436.

604-2.04 Bolts and Nuts:

Bolts and nuts shall conform to the requirements of ASTM A307.

604-2.05 Steel Forgings:

Steel forgings shall conform to the requirements of Subsection 1004-5 of the specifications.

604-2.06 Castings:

Carbon steel castings, gray iron castings and malleable iron castings shall conform to the requirements of Subsection 1004-6 of the specifications.

604-2.07 Bronze Castings and Copper-Alloy Plates:

Bronze castings and copper-alloy bearings and expansion plates shall conform to the requirements of Subsection 1004-7 of the specifications.

604-2.08 Welded Stud Shear Connectors:

Shear connector studs shall conform to the requirements of ASTM A108, Grades 1015, 1018, or 1020, and to the requirements of Section 11, Division II, Construction - Steel Structures, of the AASHTO Standard Specifications for Highway Bridges.

604-2.09 Bearing Pads:

(A) Preformed Fabric Pads:

Preformed fabric pads shall conform to the requirements of Section 1013 of the specifications.

(B) Elastomeric Bearing Pads:

Elastomeric bearing pads shall conform to the requirements of Section 1013 of the specifications.

604-2.10 Certification of Structural Steel:

Certificates of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be submitted. The certificates shall include mill heat test reports showing the properties of each heat number. Mill test reports for structural steel used for those items specified in Subsection 604-2.01 of the specifications shall also include the results of the Charpy V-notch impact test values.

604-3 Construction Requirements:

604-3.01 Shop and Working Drawings:

The contractor shall prepare shop and working drawings for submittal in accordance with the requirements of Subsection 105.03 of the specifications. The submittal shall allow sufficient time for review based on the days identified in Subsection 105.03 of the specifications, within the contractor's schedule of work.

Working drawings for steel structures shall show complete fabrication and erection details including full detailed dimensions and sizes of component parts of the structure and details of miscellaneous parts such as pins, nuts, bolts, and rivets.

604-3.02 Fabrication:

Fabrication of all metal for steel structures shall be in accordance with the approved shop drawings and shall conform to the requirements of Section 11, Steel Structures, of AASHTO LRFD Bridge Construction Specifications, except as specified herein.

The structural steel fabrication plant shall be certified under the AISC Quality Certification program to the standard and supplement requirements for the type of work being performed. The following categories are defined under the AISC Quality Certification program:

Certified Bridge Fabricator - Simple (SBR)
Certified Bridge Fabricator - Intermediate (IBR)
Certified Bridge Fabricator - Advanced (ABR)

Fracture Critical members must be fabricated at a plant that has acquired an AISC Fracture Critical Endorsement (FCE).

Fabrication of steel components shall not begin until arrangements have been made for shop inspection.

In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

604-3.03 Substitutions:

Substitutions of structural steel sections having different dimensions or properties of equal or greater value than those shown on the project plans may be made only when approved in writing by the Engineer.

604-3.04 Shop Inspection:

For shop inspection of structural steel fabrication, the contractor shall provide two written notifications to the Engineer, as follows:

(A) First written notification shall be submitted at least 60 days prior to beginning work in the shop per the requirements listed herein, and in Subsections 604-3.02 of the specifications. The first written notification shall include:

(1) The name and address of the fabricator;

(2) The approximate fabrication schedule; and

(3) A description of the work to be fabricated.

Approved shop drawings are not required at the time of the first written notification, but are required before fabrication begins. Upon notification, the Engineer will contact ADOT Bridge Group to arrange for an inspector to be assigned to perform the steel shop inspection.

(B) Second written notification shall be submitted at least seven working days prior to beginning work in the shop in order for ADOT Bridge Group to schedule the shop inspection.

The contractor shall furnish all facilities for the inspection of material and workmanship in the shop in accordance with the requirements of Subsection 106.06 of the specifications.

Inspection at the shop is intended as a means of facilitating the work and avoiding errors, and it is expressly understood that it will not relieve the contractor from any responsibility in regard to defective material or workmanship and the necessity of replacing defective material or doing the work again. Reinspection costs incurred by the Department due to contractor errors shall be reimbursed by the contractor.

604-3.05 Galvanizing:

(A) Structural Steel for bridges shall only be galvanized when specified on the project plans. When galvanizing is so

specified, the members shall be galvanized in accordance with the requirements of ASTM A123. The weight of the coating (total for both sides) shall be the weight specified.

(B) Structural Steel for minor structures and miscellaneous work shall be galvanized when specified on the project plans. When galvanizing is so specified, the members shall be galvanized in accordance with the requirements of ASTM A123. The weight of the coating (total for both sides) shall be the weight specified.

Steel posts shall be galvanized in accordance with the requirements of AASHTO M 111 or ASTM A123.

Steel fittings, hardware, etc., shall be galvanized, when specified, in accordance with the requirements of ASTM A153. The weight of the coating shall be as specified in ASTM A153.

604-3.06 Welding:

All welding and inspection of welding for structural steel, except for tubular structures, shall be performed in accordance with the requirements of the most recent edition of the ANSI/AASHTO/AWS Bridge Welding Code. All other references to the American Welding Society (AWS) structural welding code AWS D1.1-80 and the AASHTO Standard Specifications for welding of structural steel highway bridges are deleted.

The use of electro-slag welding process on structural steel will not be permitted.

In addition to the above requirements, welding of Fracture Critical Members (FCMS) shall be performed in accordance with the AASHTO Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members, 1978, revised to date.

604-3.07 Painting:

All steel and iron surfaces shall be cleaned and painted in accordance with the requirements of Section 610 of the specifications.

604-3.08 Erection:

Erection of steel structures shall be in accordance with the requirements of Division II, Construction, Section 11, Steel Structures, of AASHTO Standard Specifications for Highway Bridges.

Straightening of bent metal members will not be permitted unless otherwise permitted by the Engineer.

604-4 Method of Measurement:

Structural steel for steel structures will be measured by the pound or will not be measured but will be paid for on a lump sum basis in accordance with the following:

(A) Weight Basis:

Unless otherwise specified, this method of measurement shall conform to the requirements of Article 11.7, Division II, Construction, Section 11, Steel Structures, of AASHTO Standard Specifications for Highway Bridges and the pay quantities of structural steel will be determined on the basis of computed net weights.

The weights of plates 36 inches or less in width will be computed on the basis of the nominal weight for their width and thickness as shown on the project plans.

(1) Structural Steel:

All rolled section girders, welded plate girders, structural steel plate or shapes used for splice plates, stiffeners or diaphragms, shear connectors, corresponding weld metal, nuts, and bolts, will be measured for payment as structural steel.

(2) Structural Steel (Miscellaneous):

All other structural steel items including rockers, rollers, bearing plates, pins and nuts, brackets, plates, shapes for sign mounts on bridges, steel traffic rail, corresponding weld metal, nuts and bolts, and similar steel items not covered in other contract items will be measured for payment as structural steel (miscellaneous).

(B) Lump Sum Basis:

The project plans will show an estimated net weight of structural steel required for the structure work. This quantity shall be considered as approximate only. It shall be the responsibility of the bidder to determine the exact quantities of structural steel from computations based upon the details and notes shown on the project plans. No measurement of the quantities of structural steel determined by the contractor will be made, unless an alteration in the work is ordered. When an alteration in the work is ordered which increases or decreases the quantity of structural steel required, the amount of the increase or decrease will be measured by the pound.

604-5 Basis of Payment:

Structural steel for use in steel structures will be paid at the contract unit price per pound or at the contract lump sum price, complete in place.

When the lump sum basis of payment is specified and an alteration in the work is ordered which increases or decreases the quantity of structural steel required, a theoretical unit price, determined by dividing the lump sum bid price by the total estimated quantity of structural steel shown on the project plans, will be the basis for payment for the increase or decrease in quantity. The theoretical unit price will be subject to adjustment, all in accordance with the provisions of Subsection 104.02 of the specifications.

No measurement or direct payment will be made for any additional weight resulting from substitution of structural steel sections as specified in Subsection 604-3.03 of the specifications.

Partial payment may be made in accordance with the provisions of Subsection 109.07 of the specifications.

SECTION 605 STEEL REINFORCEMENT:

605-1 Description:

The work under this section shall consist of fabricating, furnishing, and placing steel reinforcement of the quality, coating, type, size, shape, and quantity designated, all in accordance with the details shown on the project plans and the requirements of these specifications.

605-2 Materials:

Steel reinforcing bars, wire, and welded wire fabric shall conform to the requirements of Section 1003 of the specifications.

605-3 Construction Requirements:

605-3.01 General:

When the project plans show a bar list and bending diagram, the contractor shall carefully check the schedule against the details in advance of ordering materials.

When bar bending diagrams are not shown on the project plans, shop drawings and lists showing the bending of reinforcement bars shall be submitted by the contractor to the Engineer for approval, but such approval shall not relieve the contractor of responsibility for the correctness of such drawings and lists.

Any discrepancy or error found by the contractor in checking a bar list or bending diagram shown on the project plans or in preparing shop drawings or lists shall be reported immediately to the Engineer, and the discrepancy or error shall be corrected in advance of fabrication and delivery of materials.

Steel reinforcement shall be protected at all times from damage. When placed in the work, all reinforcement shall be free of dirt, oil, paint and grease. Rust, surface irregularities or mill scale shall not be cause for rejection, provided the weight, dimensions, cross-sectional area and tensile properties of a manually wire brushed test specimen are not less than the requirements of these specifications.

When bending is required, it shall be done without the use of heat, and bars having cracks or splits at the bends will be rejected. Grade 40 bars which are No. 8 and larger and all sizes of Grade 60 bars shall not be rebent at the same location. Grade 40 bars which are size No. 7 and smaller may be rebent once at the same location.

Reinforcement shall be accurately fabricated and placed as shown on the plans and shall be firmly held in place by wire ties at all intersections and splices with 16 gauge or heavier tie wires and with precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, or other approved supports at the spacing necessary to maintain the specified clearance of the reinforcing steel. The use of pebbles, broken stone, concrete masonry blocks, brick, metal pipe, or wood blocks will not be permitted for the purpose of spacing or support.

The contractor has the option to submit a request detailing the use of contract or buried bars, including supporting drawings, for review and approval by the Engineer.

For reinforcement spacing is greater than or equal to 12 inches in either the longitudinal or transverse directions, the reinforcement shall be tied at a minimum every alternate intersection.

Where reinforcement spacing is less than 12 inches in either the longitudinal or transverse directions, the reinforcement shall be tied at a minimum, every third intersection.

The contractor may submit a request detailing an alternative tying plan for review and approval by the Engineer.

Before placing the pier column and superstructure reinforcement, the contractor shall insure that the vertical reinforcing steel will not interfere with the horizontal cap reinforcing steel and tendon ducts. Reinforcing steel shall not be cut to facilitate installation.

The following tolerances will be allowed when placing, tying, and supporting reinforcing steel:

(A) In slabs and beams, horizontal bars shall be within 1/4 inch, measured vertically, of the position indicated on the plans;

(B) In vertical walls, columns, wings, and similar members, clearance from the forms shall be within 1/4 inch of the clearance shown on the plans; and

(C) In slabs or walls, long runs of bars may vary up to two inches in spacing; however, the specified number of bars shall be placed.

No concrete shall be placed until reinforcement in the member has been inspected and approved by the Engineer. Reinforcement which does not conform to the above tolerances shall be adjusted or repaired prior to concrete placement.

When required by the project plans, all reinforcement and all other steel elements to be encased in the concrete of a bridge deck or bridge barriers shall be epoxy coated. Reinforcement that is to be partially within these concrete elements, but extends into other structural elements, will not require coating on that part which is to be outside the bridge deck or bridge barrier concrete.

605-3.02 Splicing and Lapping:

All reinforcement shall be furnished in the full lengths indicated on the project plans. Splicing of bars, except as shown on the plans, will not be permitted without the Engineer's approval. Splices shall be staggered as far as possible. The type and method of splices or connections shall be approved by the Engineer.

The contractor may use either lap splices, full welded splices, or mechanical connections for reinforcement bars up to and including bar size No. 11. Where the bar size exceeds No. 11, full welded splices or mechanical connections shall be used. Welded splices shall not be used on epoxy-coated bars, and no welding shall be performed close enough to epoxy-coated bars to cause any heating of the coating. All exterior surfaces of positive connectors for epoxy-coated bars shall have the same coating as the bar.

In lapped splices, the bars shall be placed in contact with one another and wired together in such a manner as to maintain a clearance of not less than the minimum clear distance to other bars and the minimum distance to the surface of the concrete, as specified in the AASHTO Standard Specifications for Highway Bridges. Lap lengths shall be as shown on the plans.

A full welded splice is one in which the bars are butted and welded to develop, in tension, at least 125 percent of the specified yield strength of the bar. Test requirements shall be as specified in AWS D 1.4.

Welding shall be performed in accordance with the requirements of Subsection 604-3.06 of the specifications.

A mechanical connection is one in which the bars are connected to develop an ultimate strength, in tension or compression as required, of at least 125 percent of the specified yield strength of the bar.

Except as otherwise specified, mechanical splices shall be made in accordance with the manufacturer's recommendations as approved by the Engineer. As a condition of approval, the contractor shall make three test splices in the presence of the Engineer of each size it intends to splice. Two of the test splices shall be tension tested to 125 percent of the specified yield strength of the bar and one splice shall be tested to destruction by an approved laboratory and certified reports of the tests shall be submitted to the Engineer for approval. Field splices shall be subject to visual inspection and physical testing. A minimum of 2 percent of the field splices chosen at random by the Engineer shall be removed and tested to 125 percent of specified yield strength by the Engineer. Samples shall be at least 42 inches long with the splice at mid length.

Sheets of welded wire fabric or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one mesh width.

605-3.03 Epoxy - Coated Reinforcement:

(A) General:

The requirements of this subsection for epoxy-coated reinforcement are in addition to the previous requirements which apply to un-coated reinforcement.

(B) Field Operations - Epoxy-Coated Bar Reinforcement:

All handling systems for coated bars shall have padded contact areas for the bars wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong back, multiple supports or a platform bridge so as to prevent bar to bar abrasion from sags in the bar bundle. The bars or bundles shall not be dropped or dragged.

All hardware that will remain permanently in concrete using epoxy coated reinforcement shall be made of or coated with a dielectric material. Such hardware includes reinforcement chairs, tie wires, screed rail supports, or any other item that would be a potential source of corrosion. The specific hardware that the contractor proposes to use shall be approved by the Engineer.

The contractor shall be required to field repair damaged areas of the coating, and to replace items exhibiting severely damaged coatings. The material used for field repair shall be that supplied by the coating applicator.

Field repair shall be required wherever the area of coating damage exceeds 2 percent of the surface area of the bar in a one-foot length and the damaged spot is larger than 1/4 by 1/4-inch.

Field repair will not be allowed on bars which have severely damaged coatings. A severely damaged coating is defined as a coating which has a total damaged area greater than 5 percent of the surface area of the reinforcing bar. The Engineer shall be the sole determiner of the severity of damaged area for purposes of repair or replacement. A reinforcing bar having a coating determined by the Engineer to be severely damaged shall not be incorporated in the work and it shall be removed from the work site. All such bars shall be replaced in kind by the contractor at no additional cost to the Department.

605-3.04 Dowel Placement:

Dowel placement shall consist of drilling or coring dowel holes, furnishing, and placing setting materials and placing metal dowels in accordance with the details shown on the plans and the requirements of the specifications.

The diameter of dowel holes shall be 1/4 inch larger than the diameter of the dowels to be placed and the depth of the holes shall be as shown on the plans.

Setting materials shall be an approved epoxy adhesive unless otherwise specified on the plans.

The minimum tensile pull out strength of the dowel anchorage shall be as specified on the plans.

If required by the Engineer, the contractor shall submit details of the anchorage system to the Engineer prior to dowel placement.

605-4 Method of Measurement:

605-4.01 General:

No measurement for payment will be made for steel reinforcement, whether coated or uncoated as required, which is included in a precast concrete item which is listed in the bidding schedule as a unit to be paid for at a lump sum price.

Steel reinforcement that is required on the plans to be epoxy-coated for use in bridge concrete and that is partially within the deck, yet projects into other structural elements, shall be included in the measurement and payment for Reinforcing Steel (Epoxy Coated). The contractor is required to coat only that part of the reinforcement that is contained in the deck or concrete bridge barriers.

Except for that contained in a precast concrete item to be measured as a unit, steel reinforcement will be measured as a lump sum item or by the pound, as listed in the bidding schedule. Epoxy-coated reinforcement will be measured separate from un-coated reinforcement.

Dowel placement will be measured by the unit each.

605-4.02 Lump Sum Basis:

The project plans will show an estimated net weight of reinforcing steel required for the work. This quantity shall be considered as approximate only. It shall be the responsibility of the bidder to determine the exact quantities of all reinforcing steel required, by computations based upon the details and notes shown on the project plans. It is understood that the quantities of all reinforcing steel required for the work shall be furnished by the contractor, including samples for testing. Measurement of the quantity furnished will be made either when an alteration in the work is ordered or when evidence shows or there is good reason to believe that the actual quantity of reinforcing steel varies from the total quantity shown on the project plans by 3 percent or more. When an alteration in the work is ordered or when the quantity varies as herein specified, the actual quantity of reinforcing steel will be computed by the Engineer and the amount of the increase or decrease will be measured by the pound.

605-4.03 Weight Basis:

Reinforcing Steel will be measured in pounds based on the total computed weight for the size and lengths of bars, wire, or welded wire fabric as shown on the plans or authorized.

The weight of bars will be calculated from weight shown in Table 605-1.

The weight of welded wire fabric will be computed from the theoretical weight of plain wire of the corresponding gauge. If the weight per square foot is shown on the plans, that weight will be used.

In measurement of the weight of epoxy-coated steel reinforcement, no addition to or deduction from the weights shown in Table 605-1 will be made because of additional requirements for blast cleaning and epoxy coating.

When laps are made for splices other than those shown on the plans for the convenience of the contractor, the extra steel will not be included in the measurement for payment.

The measurement of samples for testing will be the weight in pounds of the samples selected by the Engineer or the weight in pounds of the full length of reinforcing steel bars supplied for sampling purposes when sampling is done at the construction site.

TABLE 605-1		
Deformed Bar Designation No.	**Weight, pounds per linear foot**	**Nominal Diameter, inches**
3	0.376	0.375
4	0.668	0.500
5	1.043	0.625
6	1.502	0.750
7	2.044	0.875
8	2.670	1.000
9	3.400	1.128
10	4.303	1.270
11	5.313	1.410
14	7.650	1.693
18	13.600	2.257

Note:

(1) The nominal diameter of a deformed bar is equivalent to the diameter of a plain round bar having the same weight per foot as the deformed bar. Bar numbers are based on the number of eighths of an inch included in the nominal diameter of the bars.

605-5 Basis of Payment:

The accepted quantities of Reinforcing Steel, of the type shown in the bidding schedule, measured as provided above, will be paid for at the contract lump sum price or the contract unit price per pound, complete in place.

The lump sum price or unit price per pound shall also include the cost of chairs, supports, fasteners, connections, tie wire, and any splices not specifically shown on the plans. If the Engineer permits the substitution of larger bars than those specified or splices not shown on the plans payment will be made only for the amount of steel which would have been required if the specified size and length had been used.

The accepted quantity of dowels placed, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work complete in place. Steel reinforcement furnished for dowels will be measured and paid for under the Reinforcing Steel item.

No measurement or direct payment will be made for furnishing and placing dowels which are required to replace existing reinforcing steel that is damaged as a result of the contractor's operations.

SECTION 606 OVERHEAD SIGN STRUCTURES:

606-1 Description:

The work under this section shall consist of furnishing and installing overhead sign structures in accordance with the details shown on the plans and in accordance with the requirements of these specifications. The type of sign structure to be installed at each location shall be as shown on the project plans.

606-2 Materials:

606-2.01 General:

Certificates of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for all structural steel. Mill test reports for structural steel used as specified under Subsection 606-2.02 of the specifications shall include the results of the Charpy V-notch impact test values.

606-2.02 Structural Shapes, Plates, and Bars:

Shapes, plates, and bars for trusses, columns, and walkway assemblies of the sign structures shall be fabricated from structural steel conforming to the requirements of ASTM A36.

Structural steel used for the fabrication of columns or girder flanges, web plates, and truss chord angles shall be in accordance with longitudinal Charpy V-notch impact test values specified in Subsection 604-2.01 of the specifications.

606-2.03 Tapered Tubes:

Tapered tube beams, arms, and poles for the bridge single beam sign structures and for the cantilever double arm sign structures shall be fabricated from structural steel conforming to the following requirements: ASTM A36, ASTM A283, ASTM A1011, ASTM A595 Grade A, ASTM A572 Grade 65 or equivalent, and have a minimum yield strength of 50, 55, or 65 kilopounds per square inch after fabrication.

606-2.04 Pipe Poles for Cantilever Truss:

Poles shall be welded or seamless steel pipe conforming to the requirements of ASTM A53, Type E or S or A500, Grade B.

606-2.05 Bolts, Nuts, and Washers:

High-strength steel bolts, nuts, and washers shall conform to the requirements of ASTM F3125 GR A325. All other bolts and nuts shall

conform to the requirements of ASTM A307 and shall be furnished with commercial quality washers.

Anchor bolts for the sign foundations shall conform to the requirements of ASTM F1554 Grade 55.

All bolts, nuts, and washers, except high-strength bolts and anchor bolts, shall be cadmium plated in accordance with the requirements of ASTM B766 or zinc plated in accordance with the requirements of ASTM B633.

606-2.06 Concrete:

Concrete for all sign structure foundations shall be Class S (f'c = 3,500 pounds per square inch) conforming to the requirements of Section 1006 of the specifications.

606-2.07 Reinforcing Steel:

Reinforcing steel bars shall conform to the requirements of ASTM A615 Grade 60. Unless otherwise specified, steel bars meeting the requirements of ASTM A706 may be substituted for ASTM A615 steel bars. When ASTM A706 bars are used, tack welding of the reinforcement will not be permitted unless approved in writing by the Engineer. Reinforcing steel wire shall conform to the requirements of ASTM A82.

606-2.08 Nonshrink Grout:

Nonshrink grout shall conform to the requirements of ASTM C1107 and shall be approved by the Engineer. Grout shall be mixed, handled and placed in accordance with the manufacturer's recommendations.

606-3 Construction Requirements:

606-3.01 Shop Drawings:

The contractor shall furnish shop drawings for approval by the Engineer prior to fabrication of the sign structure material. Shop drawings shall be furnished in accordance with the requirements of Subsection 105.03 of the specifications. The foundation shall be set at the elevation called for in the project plans and the embankment graded to match the top of the foundation as directed by the Engineer.

606-3.02 Fabrication:

Fabrication of component parts of the sign structures shall be in accordance with the approved shop drawings and shall conform to the requirements of Section 11, Steel Structures, of AASHTO LFRD Bridge Construction Specifications.

Fabrication of steel components shall not begin until arrangements have been made for shop inspection. Shop inspection of structural steel fabrication shall conform to Subsection 604-3.04 of the specifications.

606-3.03 Welding:

Welding of structural tubing shall conform to the requirements of the American Welding Society, Structural Welding Code - Steel, D1.1, latest edition.

606-3.04 Galvanizing:

All steel surfaces of sign structures shall be galvanized after fabrication. Galvanizing shall conform to the requirements of ASTM A123 and A153.

606-3.05 Foundations:

Reinforced concrete foundations for the sign structures shall be constructed to conform to the details shown on the plans and in accordance with the requirements of Subsections 609-1 through 609-3 of the specifications.

Concrete shall be placed, finished and cured in accordance with the requirements of Section 601 of the specifications.

606-4 Method of Measurement:

Overhead sign structures will be measured by the unit of each type or types of sign structures furnished and erected.

Foundations for the sign structures will be measured by the unit of each type or types of foundation constructed.

606-5 Basis of Payment:

The accepted quantities of various types of overhead sign structures and foundations, measured as provided above, will be paid for at the contract unit prices complete in place.

The contract unit price paid per unit for each type and size of sign structure designated in the bidding schedule shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and erecting the sign structures complete in place, including painting, galvanizing if necessary, furnishing and placing nonshrink grout, furnishing tapered tube sign mounting brackets, and all necessary hardware except for anchor bolts which are considered as part of the foundations, all as shown on the plans and as specified in these specifications.

The contract unit price for each type of sign structure foundation designated in the bidding schedule shall include full compensation for furnishing all labor, materials, tools, equipment ,and incidentals, and for doing all the work involved in constructing foundations, complete in place, including steel reinforcement, furnishing and installing anchor bolts, all necessary excavation, backfilling, and disposing of excess excavated material, all as shown on the plans and as specified in these specifications.

SECTION 607 ROADSIDE SIGN SUPPORTS:

607-1 Description:

The work under this section shall consist of furnishing and installing roadside sign supports in accordance with the details shown on the plans and the requirements of the specifications.

Sign supports shall consist of breakaway, slip base, perforated and U-channel sign posts. The type, size, and installation location of the sign posts will be shown on the project plans.

607-2 Materials:

607-2.01 General:

Certificates of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for breakaway sign post shapes

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for perforated sign posts and U-channel sign posts.

607-2.02 Breakaway Sign Post Shapes:

Posts shall be fabricated from structural steel conforming to the requirements of ASTM A572, Grade 50 or ASTM A588 at the option of the contractor. Base plates for the breakaway connections and friction fuse plates and back plates for the post hinge assembly shall be fabricated from the same type structural steel selected for the sign posts.

All plate holes shall be drilled and all plate notches shall be saw cut, except that flame cutting will be permitted provided all edges are ground. Flange holes shall be drilled or sub-punched and reamed. The posts shall be saw cut for the hinge and bolted as detailed on the plans.

Bolts, nuts and washers shall conform to the requirements of ASTM A325.

Posts and plates shall be galvanized after fabrication in accordance with the requirements of ASTM A123. Bolts, nuts, and washers shall be cadmium plated in accordance with the requirements of ASTM B766, or zinc plated in accordance with the requirements of ASTM B633.

607-2.03 Perforated Sign Posts:

Single and telescoping perforated posts shall be square tube fabricated from galvanized sheet steel. The sheet steel shall have a thickness of 0.105 inches (12 gauge) or 0.135 inches (10 gauge) as required by the project specifications. Sheet steel shall conform to the requirements of ASTM A653 for either SQ Grade 40 or SQ Grade 50 Class 1, and be galvanized in accordance with the requirements of Coating Designation G-90. The posts shall have a wall thickness, including coating, of 0.097 to 0.116 inches for 12 gauge and 0.127 to 0.146 inches for 10 gauge.

Posts shall be welded directly in the corner by high frequency resistance welding or equal. The outside edges of the posts shall be scarfed as necessary to produce a standard corner radii of 5/32 ± 1/32 inch.

External welded surfaces and scarfed areas shall be re-galvanized after fabrication.

Holes 7/16 ± 1/64 inch in diameter shall be provided on 1-inch centers along all four sides over the entire length of the post. The holes shall be laterally centered on the longitudinal centerline of each face. Hole positioning and spacing shall be the same on all four faces, such that the hole centerlines for each group of four holes shall pass through a common point on the longitudinal centerline of the tube. For telescoping posts, holes shall be in proper alignment to allow 3/8-inch diameter bolts to pass through the entire post.

The finished posts shall be straight and have a smooth, uniform finish. All consecutive sizes of posts shall be freely telescoping for not less than 10 feet of their length without the necessity of matching any particular face to any other face.

Perforated sign posts shall be manufactured by an approved manufacturer. A list of approved manufacturers of perforated sign posts is shown on the Department's Approved Products List (APL). Copies of the most current version of the APL are available on the internet from the Arizona Transportation Research Center (ATRC), through its Product Evaluation Program.

Bolts shall conform to the requirements of SAE Specification J429, Grade 5, or ASTM A449, Type 1. Nuts shall conform to the requirements of ASTM A563, Grade A. Washers shall conform to the requirements of ASTM F844.

Bolts, nuts, and washers shall be zinc coated in accordance with the requirements of ASTM B633 or cadmium plated in accordance with the requirements of ASTM B766.

607-2.04 U-Channel Sign Posts:

U-channel posts shall be fabricated from rerolled rail steel or hot-rolled carbon steel bars.

Prior to rerolling the rail steel, the rail nominal weight shall be 91 pounds per yard and shall meet the requirements of ASTM A1 pertaining to quality assurance.

Yield Point of the steel shall be 80,000 pounds per square inch minimum.

The cast heat analysis of the steel shall conform to the following requirements:

Element	Composition (Percent)
Carbon	0.67 - 0.82
Manganese	0.70 - 1.10
Phosphorus: Max.	0.04
Sulfur: Max.	0.05
Silicon	0.10 - 0.25

Posts shall be a uniform, modified, flanged channel-section as shown in the plans. Weight of the posts shall be three pounds per lineal foot, plus or minus 5 percent. The post shall be punched with continuous 3/8-inch diameter holes on 1-inch centers. The first hole shall be 1 inch from top and bottom of post.

The post shall consist of two parts, a sign post and a base post. The sign post lengths shall be supplied in 6-inch increments up to 12 feet as required for the installation location. The base posts shall be 42 inches in length, pointed at one end, and have at least 18 holes in the base post, starting 1 inch from the top and continuing at 1-inch increments.

Posts shall be machine straightened to have a smooth uniform finish, free from defects affecting their strength, durability, or appearance. All holes and rough edges shall be free from burrs. The permissible tolerance for straightness shall be within 1/16 inch in 3 feet.

Posts shall be galvanized after fabrication in accordance with the requirements of ASTM A123. Bolts, nuts, washers, and spacers shall be cadmium plated in accordance with the requirements of ASTM B766 or zinc plated in accordance with the requirements of ASTM B633.

For shipment, the posts shall be nested and fastened in such a manner that they will not slip. Care shall be taken during shipping to minimize the rubbing of posts together resulting in damage to the galvanized finished surface. Excessive damage to the finish of the posts during

shipping or handling will result in rejection of the damaged posts. Posts shall be bundled in groups of no more than 100.

U-channel base posts shall be driven into the ground to a depth of 38 inches. Where rock is encountered, the rock shall be cored, drilled, or removed to a minimum diameter of 8 inches and to a depth sufficient to place Portland cement concrete 2 inches below the bottom of the base post and fill the hole to within 1 inch of the top. Solid rock coring or drilling is not required to continue beyond 24 inches in depth regardless of the depth at which the rock is encountered. The base post may be cut at the bottom prior to being set in Portland cement concrete where rock does not permit use of full length base post.

607-2.05 Concrete:

Concrete for breakaway sign post foundations shall be Class B, except that utility concrete may be used for foundations using stub post sizes S 3 x 5.7 and S 4 x 7.7. Class B concrete shall conform to the requirements of Section 1006 of the specifications and utility concrete to the requirements of Section 922 of the specifications. Concrete for perforated sign posts foundations and U-channel sign post foundations, when required, shall conform to the requirements of Subsections 922-2 and 922-3 of the specifications.

Foundation stub posts shall be fabricated from the same type of steel selected for the appropriate sign posts. Breakaway stub posts shall be galvanized a minimum of 12 inches down from the top of the stub. Galvanizing shall be in accordance with the requirements of ASTM A123.

Reinforcing steel bars for breakaway sign post foundations shall conform to the requirements of ASTM A615. Unless otherwise specified, steel bars meeting the requirements of ASTM A706 may be substituted for ASTM A615 steel bars. When ASTM A706 bars are used, tack welding of the reinforcement will not be permitted unless approved in writing by the Engineer. Reinforcing steel wire shall conform to the requirements of ASTM A82.

607-2.06 Slip Base:

Slip bases shall be manufactured by an approved manufacturer. A list of approved manufacturers of slip bases is shown on the Department's Approved Products List (APL).

607-3 Construction Requirements:

Fabrication of the breakaway sign posts, stub posts, and base plates shall conform to the requirements of Subsection 604-3.02 of the specifications, except that shop drawings will not be required.

Breakaway sign post lengths will be determined by the Engineer at the time of construction staking and will be furnished to the contractor prior to ordering fabrication of the sign posts.

Perforated and U-channel sign post lengths shall be determined by the contractor at the time of construction staking. Posts shall be cut to the proper lengths in the field. Splicing will be permitted for single perforated posts; however, splices will be limited to one per each post installation and the splicing shall be accomplished in accordance with the details shown on the plans. The minimum length of any spliced piece of post shall be 2 feet.

Foundations for the breakaway sign posts, perforated sign posts and when required, U-channel posts shall be constructed to the details and dimensions shown on the plans. Concrete shall be placed in accordance with the requirements of Section 601 or 922 of the specifications, as the case may be. Excavation shall conform to the requirements of Subsection 203-5.03(A) of the specifications.

Sign posts shall be erected plumb and shall be bolted to the foundation stub or base posts in accordance with the procedure specified on the plans.

Slip bases shall be assembled as shown in the Standard Drawings and installed in accordance with the manufacturer's instructions.

607-4 Method of Measurement:

Breakaway sign posts will be measured by the linear foot for each size of post furnished and erected. The length of each size of post will be measured from the bottom of the upper base plate to the top of the post, measured to the nearest 0.1 feet. The total length of all posts of the same size will be rounded to the nearest foot.

Perforated sign posts will be measured by the linear foot of each type of post furnished and installed. The length of each type of post will be measured from the top of the concrete post foundation to the top of the post, measured to the nearest 0.1 feet. The total length of all posts of the same type will be rounded to the nearest foot. Telescoping post members will be considered as one post after installation and will not be measured separately. U-channel posts will be measured as each.

Foundations for signposts will be measured by the unit for each type of foundation constructed, except that concrete and excavation, when required for setting U-channel base posts, will be considered as part of the post.

Slip base for sign posts will be measured by the unit of each.

607-5 Basis of Payment:

The accepted quantities of breakaway posts, perforated posts, U-channel posts, and foundations for the sign posts, measured as provided above, will be paid for at the contract unit prices complete in place.

The contract unit price paid per linear foot for each size of breakaway sign post, each type of perforated sign post and each installation of U-channel post designated in the bidding schedule shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and erecting the sign posts, complete in place, including galvanizing and furnishing all metal plates and hardware, all as shown on the plans and as specified herein.

The contract unit price paid per unit for each type of sign foundation designated in the bidding schedule shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing foundations, complete in place, including the steel stub posts, lower base plate, and steel reinforcement (except for stub posts S 3 x 5.7 and S 4 x 7.7) for the breakaway sign post foundation; the portion of perforated post within the foundations; galvanizing the posts; and excavation, all as shown on the plans and as specified herein.

The accepted quantities of slip base for the sign posts, measured as provided above, will be paid for at the contract unit price per each, complete in place.

SECTION 608 SIGN PANELS:

608-1 Description:

The work under this section shall consist of furnishing and installing sign panels in accordance with the details shown on the plans and the requirements set forth herein.

The sign panels shall be of the following types:

(A) Extruded Aluminum Sign Panels with Direct-Applied or Demountable Characters;

(B) Flat Sheet Aluminum Sign Panels with Direct-Applied, Electronic-Cut, or Screen-Printed Characters;

(C) Warning, Marker, and Regulatory Sign Panels;

(D) Route Shields for Installation on Sign Panels; and/or

(E) EXIT ONLY Panels for Installation on Sign Panels.

The work under this section shall also include furnishing and installing graffiti shield on overhead extruded sign panels in accordance with the details shown on the plans and as specified herein.

608-2 Materials:

608-2.01 General:

Certificates of Compliance, conforming to the requirements of Subsection 106.05 of the specifications, shall be submitted for all materials required for fabricating sign panels, including retroreflective sheeting.

Shipment, storage, and handling of sign panels shall conform to the recommendations of the manufacturers of the sign panel components. Fabricated signs and overlay sheets shall be shipped on edge. Damage to the sign panel or legend resulting from banding, crating, or stacking may be cause for rejection of the signs.

Signs shall be fabricated in accordance with the recommendations established by the manufacturer of the sign sheeting. All processes and materials used to make a sign shall in no way impact the performance, uniform appearance (day and night), or durability of the sheeting, or invalidate the sign sheeting manufacturers' warranty.

All sheeting used for background and legend shall be from the same manufacturer. Sign panels shall not be overlaid.

All text and numerals shall all be installed at the same orientation: either zero degrees or 90 degrees.

Design of letters and numbers shall be in accordance with the project plans with a tolerance of ± 1/16 of an inch.

The contractor shall not paint the bolts or the washers unless otherwise specified.

608-2.02 Extruded Aluminum Sign Panels with Direct-Applied or Demountable Characters:

Panels shall be fabricated from 12-inch wide aluminum extrusions formed from Aluminum Alloy 6063-T6 conforming to the requirements of ASTM B221 and fastened together by bolt connections as shown on the plans.

Panel facing shall be covered with retroreflective sheeting of the color specified on the plans. The retroreflective sheeting shall conform to the requirements of Section 1007 of the specifications.

The letters, numerals, symbols, borders, and other features of the sign message shall be direct-applied, or demountable, and shall conform to the requirements of Subsection 608-2.08 or Subsection 608-2.09 of the specifications.

Panel surfaces to be covered with retroreflective sheeting shall be prepared in accordance with the recommendations of the sheeting manufacturer. Panel surfaces not covered with sheeting shall be etched in accordance with the recommendations of the extrusion manufacturer to reduce glare from reflected sunlight.

After all fabrication has been completed, including the cutting and punching of holes, except holes for demountable letters, numerals, symbols, and borders, the aluminum extrusions shall be degreased and the retroreflective sheeting shall be applied.

Aluminum extrusions shall be flat with 1/4 inch of tolerance allowed in an 8-foot length, with proportionally greater tolerances permitted on lengths greater than 8 feet. Flatness tolerance across the face of each extrusion shall be 0.5 percent of the width.

Aluminum extrusions shall be bolted together on 12-inch centers with a maximum allowable gap of 1/32 inch between extrusions.

Shop fabricated sub-assemblies shall be rigidly braced for transportation and erection. Hardware utilized to fasten panels to supports shall conform to the panel manufacturer's recommendations.

Each completed sign panel shall be provided with a side trim molding fabricated from extruded Aluminum Alloy 6063-T6 conforming to the requirements of ASTM B221. The trim molding shall be fastened to each individual 12-inch aluminum extrusion with two 5/32-inch diameter self-plugging aluminum blind rivets, 2-1/2 inches from either edge. The exposed surface of the side trim molding shall be treated by etching as recommended by the manufacturer to reduce glare from reflected sunlight.

Each completed sign panel shall be shipped with sufficient bolt clamps placed to install the panel on the sign posts as shown in the plans. Bent bolt channels will be cause for rejection of the sign panel.

608-2.03 Flat Sheet Aluminum Sign Panels With Direct-Applied, Electronic-Cut, or Screen-Printed Characters:

Panels shall be fabricated from 0.125-inch thick 5052-H36, or 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B209.

Panel facing shall be prepared and covered with retroreflective sheeting in accordance with the recommendations of the sheeting manufacturer.

The color of the sheeting shall be as specified on the plans or as shown in the Manual of Approved Signs.

All surfaces not covered shall be etched to reduce glare from reflected sunlight.

The retroreflective sheeting shall conform to the requirements of Section 1007 of the specifications. Splicing of retroreflective sheeting shall not be allowed on sign panels having a minimum dimension up to and including 4 feet.

Messages shall be reflectorized white or, if called for on the plans, opaque black, and shall be produced by either screen printing, direct-applying, or electronic cutting, as specified under Subsection 608-2.09 of the specifications.

608-2.04 Warning, Marker, and Regulatory Sign Panels:

Panels shall be fabricated from flat sheet aluminum and shall be reflectorized as specified herein.

Panels shall be fabricated in one piece from 0.125-inch thick 5052-H36, 5052-H38, or 6061-T6 Aluminum Alloy conforming to the requirements of ASTM B209.

All surfaces of panels to be covered with retroreflective sheeting shall be prepared in accordance with the recommendations of the sheeting manufacturer. Surfaces not covered shall be etched to reduce glare from reflected sunlight. Retroreflective sheeting shall conform to the requirements of Section 1007 of the specifications.

Warning signs shall be reflectorized with fluorescent yellow retroreflective sheeting.

Regulatory signs shall be reflectorized with white retroreflective sheeting.

Reflectorized red signs shall be reflectorized with white retroreflective sheeting. The red color shall be produced by screen printing.

Regulatory signs with reflectorized red circles and slashes shall be reflectorized with white retroreflective sheeting. The red color shall be produced by screen printing.

Interstate route markers shall be cut to shape. The colors and legend shall be as shown on the plans and shall be reflectorized with white retroreflective sheeting. The Interstate route colors shall be screen-printed. The numerals may be screen-printed, electronic-cut, or direct-applied characters.

United States, State Route, and Cardinal Direction markers shall be reflectorized with white retroreflective sheeting unless otherwise shown on the plans.

Splicing of retroreflective sheeting shall not be allowed on sign panels having the minimum dimension up to and including 4 feet.

608-2.05 Route Shields (For Installation on Sign Panels):

Route shields may be demountable or direct-applied.

Demountable route shields shall be cut to shape and shall consist of 0.063-inch thick, 5052-H36, or 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B209. The aluminum shall be degreased and etched in accordance with the recommendations of the sheeting manufacturer. Retroreflective sheeting shall be white and shall conform to the requirements of Section 1007 of the specifications. Route shields shall be attached to the sign panel with self-plugging aluminum blind rivets.

608-2.06 EXIT ONLY Panels (For Installation on Sign Panels):

EXIT ONLY panels may be demountable or direct-applied. Demountable EXIT ONLY panels shall be attached to the sign panel with self-plugging aluminum blind rivets.

Demountable EXIT ONLY panels shall be fabricated from 0.063-inch thick, 5052-H36 or 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B209 with fluorescent yellow retroreflective sheeting adhered to the face side. The aluminum shall be degreased and etched in accordance with the recommendations of the sheeting manufacturer. Retroreflective sheeting shall conform to the requirements of Section 1007 of the specifications.

608-2.07 Retroreflective Sheeting, Inks, and Opaque Film:

Retroreflective sheeting, sign-making inks, and opaque films shall conform to the requirements of Section 1007 of the specifications.

608-2.08 Demountable Characters:

(A) General:

Letters, numerals, symbols, route shields, borders, and other features of the sign message shall consist of cut-out, flat sheet aluminum legends, with direct-applied sign sheeting or other finishes, that are mounted to the sign panel with rivets as described herein. All characters shall be placed on the signs in a straight and true fashion.

Flat sheet aluminum substrates used for characters and borders shall be either aluminum alloy 3105-H14, 3003-H14, 5052-H36, or 5052-H38 as specified in ASTM B209. Characters produced from the flat sheet aluminum alloy shall sit flat on the face of the sign panel without visible gap or deformation.

The thickness for letters and numbers shall be 0.032 inches. The thickness for symbols, route shields, and borders shall be 0.063 inches.

All aluminum shall be chemically treated with a chromate acid conversion type coating, or equivalent, to form an oxidation resistant barrier film that is suitable for long term outdoor application. The coating shall prevent the occurrence of oxidation that may cause streaking or discoloration on the sign. The coating shall be applied in accordance with the manufacturer's specifications, and shall have a minimum thickness of 0.002 inches.

All corners and edges of the characters shall be clean and well-defined with no apparent waviness, tears, delamination, deformation, or flaws. Burrs and waste material generated from the cutting process shall be removed so characters have a clean, flat, and correct appearance.

Design of letters and numbers shall be in accordance with the project plans.

Splicing of aluminum panels will be acceptable for diagrammatic arrows or other large symbols and shields exceeding 48 inches in more than one direction. Splices, when required, shall include a continuous 4 to 6-inch wide aluminum back plate that overlaps the joint. The back plate shall ensure no gap at the splice joint when the symbol is assembled and attached to the sign.

Borders on signs with demountable characters shall also be made of aluminum substrate panels, unless otherwise specified. However, in all cases borders on signs with demountable characters shall be made of the same material as the legend.

(B) Sheeting and Colors:

Sheeting or film applied to demountable characters shall be a continuous monolithic piece, without splice or patch, that covers the entire front face of the character. Splicing of the sheeting for demountable borders or characters which have a dimension larger than 48 inches in more than one direction will be allowed. Only one splice shall be allowed every 4 feet. When a splice is necessary, the adjoining edges shall be placed so there is no visible gap between the two pieces.

The adhesive system for sheeting and opaque films shall form a durable bond which tightly adheres to the aluminum or sign background. After attachment, the sheeting and opaque films shall not discolor, crack, craze, blister, bubble, or delaminate. Sheeting and film adhesives must

be warranted by the manufacturer against such defects as specified in Section 1007 of the specifications. Only those sheeting and film products which provide the specified warranty will be acceptable.

The color for demountable letters, numbers, symbols, and route shields on green, blue, and brown background signs shall be white, and shall conform to the requirements of Section 1007 of the specifications. Demountable legends on white and yellow background signs shall be black, and shall be opaque and non-reflective. Black characters shall be finished with laminated black opaque acrylic film.

When borders are used with demountable characters, white legend and border shall be used on green, blue, or brown sign backgrounds, and black legend and border shall be used on white or yellow sign backgrounds. Sign sheeting conforming to Section 1007 of the specifications shall be used for white borders. Black borders shall be laminated black opaque acrylic film.

Laminated black opaque acrylic film to be used for characters or borders, as specified above, shall be applied in accordance with the coating manufacturer's recommendations. The contractor shall provide copies of any warranties provided by the manufacturer to the Engineer.

On combination signs, such as a green background sign with white characters that also includes a smaller panel with yellow background and black characters, the color scheme used for the characters and border for each portion of the sign shall be as specified above, i.e. white legend and border shall be used on the green background portion of the sign and black legend and border shall be used on the yellow background portion.

(C) Attachment of Characters and Borders:

Self plugging aluminum, protruding, regular head blind rivets shall be used to secure all demountable characters. The rivets shall conform to the applicable requirements of International Fasteners Institute (IFI) 114 standard for break mandrel blind rivets. All rivets shall be 5/32 inch in diameter with the appropriate grip range.

Rivets shall be either IFI 114 Grade 10 or 11 aluminum alloy rivets. The rivets shall have an ultimate shear and tensile strength that has been determined by IFI 135 Specification 2.1 and 2.2. The ultimate shear and tensile strength shall meet or exceed those values specified for a 5/32 inch (0.1562) nominal rivet diameter per IFI 114 Table 6 for Grades 10 or 11. A higher strength and grade aluminum rivet can be used at the option of the sign fabricator.

Rivets securing the characters to the back panel shall be of sufficient length to ensure a secure attachment and conform to the grip length specifications of the rivet manufacturer. The determination of rivet grip length shall include the total thickness of the joint. This thickness shall

include the character (sheeting and aluminum sheet), spacer (if applicable) and the sign back panel (sheeting and aluminum extrusion).

The hole size used to install the rivets shall conform to the recommendation of the rivet manufacturer and Table 2 of IFI 114. Rivets shall be placed a minimum of four times the diameter of the rivet from the edge of the character being attached, e.g., 5/8 inch clearance for a 5/32 inch diameter rivet. Clearance shall be measured to the outside of the rivet head.

Minimum requirements for attaching demountable characters shall be as follows:

Straight numerals and letters such as "1" shall have three rivets, one at the top, middle and bottom. The more complex numerals and letters shall have from four to seven rivets. Letters such as "W" and "M" typically require seven rivets. Letters and numerals such as "P", "H" and "9" typically require six rivets. Letters and numerals such as "G", "S", "2", "3" and "7" typically require five rivets. A rivet shall secure each corner of the letter or numeral. For shields and symbols, rivets shall be spaced evenly around the entire perimeter. Additional rivets shall be added in the middle of the shield or symbol as necessary to eliminate bowing. Rivets for borders shall be spaced evenly around the border.

The actual number of rivets used will depend on the thickness, configuration, weight, position (with or without spacers), size of the character being attached, and the recommendations of the rivet manufacturer. The number and location of rivets shall be sufficient to secure the character to the panel so it shall not miss-align, bend or move when subjected to wind loading. Additionally, the number of rivets used shall ensure that the character does not bow or pull away from the back panel for the life of the sign. Rivets shall be placed in a defined, evenly spaced pattern which is consistent from character to character. The placement and pattern of rivets shall not interfere with the appearance of the sign from normal drive-by viewing distances. The contractor shall supply standard punch details prior to fabrication.

The protruding head and shaft of the rivets shall closely match the color of the character on which they are being applied, e.g., black characters shall be applied with black rivets. Aluminum colored rivets are acceptable for mounting white characters.

The coating used to color the rivets shall be a factory-applied anodized type finish, or equivalent, that is suitable for long term outdoor application. The coating shall have durable colorfastness and shall be capable of preventing the occurrence of oxidation that may cause streaking or discoloration on the sign. Non-factory painting of the protruding heads of the rivets is not acceptable.

608-2.09 Screen-Printed, Direct-Applied, and Electronic-Cut Characters:

Screen-printed letters, numerals, arrows, symbols, and borders, shall be applied on the retroreflective sheeting background of the sign by direct or reverse screen process. Messages and borders of a color darker than the background shall be applied to the retroreflective sheeting by direct process. Messages and borders of a color lighter than the sign background shall be produced by the reverse screen process.

Opaque or transparent colors, inks, and paints used in the screen process shall be of the type and quality recommended by the manufacturer of the retroreflective sheeting.

The screening shall be performed in a manner that results in a uniform color and tone, with sharply defined edges of legends and borders and without blemishes on the sign background that will affect intended use.

Signs, after screening, shall be air dried or baked in accordance with the manufacturer's recommendations to provide a smooth hard finish. Any signs on which blisters appear during the drying process will be rejected.

Direct-applied letters, numerals, symbols, borders, and other features of the sign message shall be cut from black opaque or retroreflective sheeting of the color specified and applied to the retroreflective sheeting of the sign background in accordance with the instructions of the manufacturer of the retroreflective sheeting.

Direct-applied legend may be moved vertically 1/2 inch to avoid placing only a small amount of material over the adjacent extruded panel. The bottom of all characters for a line of legend shall line up within 1/8 of an inch.

Electronic-cut characters shall be cut from translucent acrylic sheeting using computerized automated cutting processes.

608-2.10 Digital Printing of Signs:

Digital printing of signs shall utilize a matched component system, including appropriate software and drivers in accordance with an APL certified retroreflective sheeting manufacturer’s warranty requirements. Finished signs shall consist of a UV-protective clear overlay applied to the entire face of the sign. Any overlays shall also be compatible with the retroreflective sheeting manufacturer’s matched component system and warranty. Digitally printed signs shall conform to the requirements of ASTM D4956 for daytime and nighttime requirements, as well as the requirements of the Department’s Traffic Engineering Guidelines and Processes (TGP) 380 and Section 1007 of the specifications.

608-2.11 Graffiti Shield:

The graffiti shields shall be made from a single continuous panel made of sheet, coil, or drawn aluminum that conforms to the requirements of

ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate, Alloy 5052-H32 (bendable to 1t). The aluminum substrate shall be 0.125 and 0.1875 inches thick. Dimensional and flatness tolerances shall conform to the applicable standards of The Aluminum Association (TAA).

The contractor shall not paint the bolts or the washers unless otherwise specified.

Each completed graffiti shield panel shall be shipped with sufficient bolt clamps placed to install the graffiti shield on the extruded sign panels as shown in the plans.

608-3 Construction Requirements:

608-3.01 Fabrication:

Fabrication of the sign panels shall be in accordance with the details shown on the plans and the requirements of these specifications. If additional details for sign panel fabrication are required, the contractor shall submit shop drawings in accordance with the requirements of Subsection 105.03 of the specifications.

Panels shall be cut to size and shape and shall be free of buckles, warps, dents, cockles, burrs, and defects resulting from fabrication.

Fabricated signs shall be stored indoors and kept dry during storage. If packaged signs become wet, all packaging material shall be removed immediately and the signs allowed to dry. The signs may be repackaged using new dry materials. If outdoor storage is necessary, all packaging materials shall be removed. Signs shall be stored on edge, above ground, in an area where dirt and water will not contact the sign face. Materials used to support stored signs shall not contact sign faces.

During fabrication of the sign panels, the contractor shall ensure the bolt holes on each sign panel are placed so the holes will not coincide with any legend and any bolts, washers, or other hardware used will not cover any portion of the legend. If the bolt holes on a sign panel do not comply with these requirements, the Engineer may reject the sign panel or accept the sign panel and require the contractor to paint the bolts, washers, and any hardware coinciding with the sign legend to match the color of the legend.

The fabrication of graffiti shields shall conform to ADOT Graffiti Shields Standard Drawing S-18.

Graffiti shields shall be powder coated per the American Architectural Manufacturers Association (AAMA) coating specifications to minimize glare, improve visibility and to provide easy maintenance against graffiti vandalism. A flat black coating shall be applied to the graffiti shields. The powder coating pre-treatment shall be accomplished mechanically,

chemically, or per the contractor's discretion via alternative processes. The powder coated products shall be wrapped and packaged by the contractor to protect the finished materials against damages.

The fabrication of the individual parts and hardware shall meet industry standards for metal work, welding, and painting, to ensure that the graffiti shields life span exceeds that of the sign it is to protect.

608-3.02 Installation of Sign Panels:

The sign panels shall be installed on overhead sign structures and roadside sign supports in accordance with the details shown on the plans and in accordance with the recommendations of the manufacturers of the sign panel components.

Minor scratches and abrasions resulting from fabrication, shipping and installation of panels may be patched; however, patching shall be limited to one patch per 50 square feet of sign area with the total patched area being less than 5 percent of the sign area. Panels requiring more patching than the specified limit will be rejected. Patches shall be edge sealed by a method approved by the retroreflective sheeting manufacturer.

Sign panels shall be attached to the posts with hex head bolts as shown in the Standard Drawings; slotted head bolts shall not be used. A cadmium-plated or zinc-plated fender washer shall be placed between the bolt head and panel face.

For flat sheet panels, bolts shall be fastened with a cadmium-plated or zinc-plated fender washer and two standard nuts. Nylon washers shall not be used. The fender washer shall be placed against the sign post, the first nut shall be tightened against the fender washer, and the second nut shall be tightened against the first nut. Bolts shall be tightened from the back by holding the bolt head stationary on the face of the panel. Twisting of the bolt head on the panel face will not be allowed.

The contractor shall provide a detailed list of all new signs installed on the project. The list shall include the sign identification code, the date each sign was installed (month and year), the fabricator of the sign, and the materials used to make the sign (manufacturer, type of sheeting, ink and film). Signs shall be listed in numerical order by route, direction, and milepost and, where more than one sign is installed at the same general location, a letter subscript. The list shall be provided in a commonly used electronic spreadsheet format and shall be submitted to the Engineer electronically. In addition to the electronic submission, the Engineer may request up to three hard copies.

Sign panels within the same sign assembly shall be placed at the same orientation along the roadway so that the entire legend of the signs appear uniform under normal viewing conditions, both day and night.

Upon fabrication or installation of each sign, the contractor shall place information on the back of the sign showing the sign identification code, the sign fabricator, the manufacturer of the sheeting used, and the month and year of the installation. The formatting of the required information shall be as shown on the standard drawings. The information shall be positioned to be readily visible from a vantage point outside the flow of traffic and not obstructed by sign posts, extrusions, stringers, or brackets. All letters shall be made of a long life material such as a black opaque acrylic film. Signs not marked as required will not be eligible for payment.

Temporary traffic control signs are exempt from the installation information requirement unless noted otherwise on the project plans.

608-3.03 Installation of Graffiti Shield:

The graffiti shield panels shall be installed on overhead extruded signage in accordance with the details shown on the standard drawing, plans and in accordance with the recommendations of the manufacturers of the sign panel components.

Graffiti shield panels shall be attached to the overhead extruded sign panels with clips as shown in the Standard Drawings.

Minor scratches and abrasions resulting from fabrication, shipping, or installation of panels may be patched. Patching shall be limited to one patch per 5 square feet of graffiti shield area. The total patched area shall be less than five percent of the graffiti shield area. Graffiti shield requiring more patching than the specified limit will be rejected.

608-3.04 Inspection:

An inspection of the completely installed sign panels will be made by the Engineer during the daytime and at night for proper appearance, visibility, color, specular gloss, and proper installation.

Each sign panel face shall be cleaned thoroughly just prior to the inspection by a method recommended by the manufacturer. The cleaning material shall in no way scratch, deface or have any adverse effect on the sign panel components.

All apparent defects disclosed by the inspection shall be corrected by the contractor at no additional cost to the Department. If color variations or blemishes between sign panel increments are visible from a distance of 50 feet either during the day or at night, the panels shall be removed and replaced at no additional cost to the Department.

Each graffiti shield component shall be cleaned thoroughly just prior to the inspection by a method recommended by the manufacturer. The cleaning material shall in no way scratch or have any adverse effect on the graffiti shield components. Inspection criteria shall include, but not

be limited to; conformity to the specification, workmanship, quality, and materials.

608-3.05 Miscellaneous Work:

The work under this section shall also include furnishing all miscellaneous materials, tools, equipment, and labor necessary to relocate exit panels to the right side of the parent sign panel; removing, cutting, and installing side trims and new or salvaged aluminum extrusions on existing sign panels; relocating large guide and exit gore signs; and cutting post tops on existing installations, as required on the plans.

608-4 Method of Measurement:

Sign panels will be measured by the square foot for each type or types of sign panels furnished and installed. Individual sign panels will be measured to the nearest 0.1 square foot. The total area of each type of sign panel will be summed and rounded to the nearest square foot.

The area of each sign panel, except for warning, regulatory and marker sign panels, will be measured per plans dimensions.

For warning, regulatory and marker sign panels, the area of each sign panel will be determined as follows:

(A) The areas of each rectangular, square, or triangular sign panel will be determined from the dimensions shown on the plans; and

(B) The area of irregular shaped signs, such as stop signs and route markers, will be determined by multiplying the maximum height in feet by the maximum width in feet, using the dimensions shown on the plans.

Graffiti shield will be measured by the square foot for each graffiti shield furnished and installed. The area will be determined by multiplying the length of the outside perimeter of the graffiti shield to the nearest 0.1 feet multiplied by 2 feet. The total area of each type of graffiti shield will be summed and rounded to the nearest square foot.

Miscellaneous Work will be measured on a lump sum basis.

608-5 Basis of Payment:

The accepted quantities of each type of sign panel designated in the bidding schedule, measured as provided above, will be paid for at the contract unit price per square foot, complete in place, regardless of the type of sheeting or type of character used on the sign panel. Payment

shall be made on the total area of each type of sign panel to the nearest square foot.

No additional payment will be made for signs with sheeting applied to both sides, the cost being considered as included in the contract unit price for the sign panel.

No measurement or payment will be made for Route Shields and EXIT ONLY Panels (for installation on sign panels), the cost being considered as included in the contract unit price for the sign panel.

The contract unit price shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for performing all the work involved in furnishing and installing the sign panels, complete in place, including furnishing and applying all retroreflective sheeting, all fastening hardware, all necessary sign supports, stringers, and post ties, all as shown on the plans and as specified herein.

The accepted quantities of graffiti shield, measured as provided above, will be paid for at the contract unit price per square foot, complete in place, as shown in the plans and as described and specified herein.

The accepted quantity of Miscellaneous Work will be paid for at the contract lump sum price, which price shall be full compensations for the work, complete in place, as shown on the plans and as described and specified herein.

SECTION 609 DRILLED SHAFT FOUNDATIONS:

609-1 Description:

609-1.01 General:

The work under this section shall include furnishing all materials and constructing reinforced concrete shafts formed within a drilled excavation. Each drilled shaft foundation shall consist of a shaft section with or without casing left in place, with or without a rock socket or a belled footing. The drilled shaft foundation shall be constructed in accordance with the details and dimensions shown on the plans and the requirements specified herein.

609-1.02 Certification:

The contractor shall be responsible to review all available geotechnical investigation reports, and its signature on the proposal form shall certify that the firm performing the drilled shaft operations, whether the prime contractor or a subcontractor, has completed this review. The geotechnical investigation reports are available on the ADOT Contracts and Specifications Group website, under Current Advertisements.

609-1.03 Installation Plan:

The contractor shall provide to the Engineer for review and approval a detailed installation plan containing the following information:

(A) List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, sampling equipment, tremies or concrete pumps, casing, etc.

(B) Details of overall construction operation sequence and the sequence of shaft construction in bents or groups.

(C) Details of shaft excavation methods, including equipment and procedures for checking the dimensions and alignment of each shaft excavation.

(D) When slurry is selected for borehole stabilization, the contractor shall submit Safety Data Sheets, quality control procedures, and disposal details.

(E) Details of methods to clean the shaft excavation.

(F) Details of reinforcement placement, including support and centralization methods, lifting equipment, and staging location for tied steel reinforcement cages prior to placement.

(G) Details of concrete mix designs and mitigation of possible loss of slump during placement, including slump loss test results in accordance with the requirements specified in the Appendix included in the Special Provisions.

(H) Details of concrete placement, including concrete volumetric charts, and the elapsed time for slump loss (as defined in Subsection 609-3.07(A) and determined by the slump loss test). The concrete placement duration (as defined in Subsection 609-3.07(A)) shall be submitted for each drilled shaft diameter.

(I) Details of casing dimensions, material and splice details.

(J) List of work experience in previous similar projects.

(K) Other information shown on the plans or as requested by the Engineer.

(L) Emergency horizontal construction joint method if unforeseen stoppage of work or interruption in concrete delivery occurs.

(M) Details of any special access or setup requirements needed to position the drill equipment to advance excavations.

The contractor's installation plan shall be developed with input from subcontractors, material suppliers, and all others with drilled shaft responsibility. The installation plan shall also identify which portion of the drill shaft construction the contractor and each of the subcontractors will be performing. The documentation required above shall be submitted to the Engineer at least four weeks before work on shafts is to begin. The Engineer will review the initial submittal within 10 working days, and subsequent submittals, as necessary, within five working days. A drilled shaft preconstruction meeting will be scheduled following the final approval of the installation plan and prior to commencement of drilling activity. All parties named in the installation plan shall be represented at the preconstruction meeting. No drilled shaft work shall be performed until the contractor's final submittal has been approved by the Engineer and the preconstruction meeting concluded. Such approval will not relieve the contractor of responsibility for results obtained by use of the installation plan, or any of its other responsibilities under the contract. The contractor shall be responsible to submit a modified installation plan each time a change is made to facilitate construction.

Unless otherwise specified in the Special Provisions, foundations of 4 feet or less in diameter and 30 feet or less in length utilized in light pole and sign post foundations shall be exempt from the requirement to perform integrity testing.

609-2 Materials:

609-2.01 Concrete:

Concrete shall conform to the requirements of Section 1006 of the specifications, with the following additions or modifications:

(A) Cement:

Where concrete is placed in drilled shaft excavations containing slurry or water, the cementitious material content of the concrete shall be between 660 and 750 pounds per cubic yard.

(B) Aggregate:

Maximum nominal aggregate size shall be limited to 1/5 of minimum clear bar spacing (vertical and horizontal), not to exceed 3/4 inch nominal for drilled shafts constructed with a wet method or with temporary casing (excluding collar-only casings), and 1 inch nominal for drilled shafts constructed with a dry method.

(C) Air-Entraining Admixtures:

Air entrainment requirements detailed in Section 1006 of the specifications shall be utilized in drilled shaft foundations.

(D) Slump:

Unless otherwise specified, or as directed by the Engineer, the concrete slump for the concrete placement duration (as defined in Subsection 609-3.07(A) of the specifications) shall be 4 to 7 inches for dry, uncased excavations and 7 to 10 inches for all other excavations.

The proposed concrete mix designs may use various admixtures to delay the concrete's initial set time and/or to reduce slump loss.

609-2.02 Reinforcing Steel:

Reinforcing steel shall conform to the requirements of Section 1003 of the specifications. Welded splices will not be allowed except as shown on the plans.

609-2.03 Casing:

Casing shall be steel and may be of unit or sectional construction. The casing shall be of sufficient strength to withstand handling and driving stresses, to withstand the pressure of concrete and the surrounding earth and to prevent seepage of water. Steel shall conform to the requirements of AASHTO M270 (ASTM A709), Grade A36, unless otherwise specified.

Should telescoped casing be used, the contractor shall not allow concrete to overfill any interior casing. Spillage must be removed from the annulus, or the shaft shall be declared deficient.

Temporary casing shall be clean, inside and out, prior to placement in the excavation. All casing shall be handled so as to limit distortion to within 2 percent of the diameter. No side shear capacity will be allowed where temporary casing installed becomes permanent. If approved by the Engineer and if conditions permit, temporary casings may be corrugated and non-watertight.

The contractor shall be responsible to compensate for loss of frictional capacity in the cased zone if temporary casing is abandoned in the shaft. Such modifications shall be approved by the Engineer, and shall be at no additional cost to the Department.

609-3 Construction Requirements:

609-3.01 General:

The methods and equipment used shall be appropriate for the intended purpose and materials encountered. The allowable methods are the dry

method, wet method, temporary casing method, or permanent casing method, as defined by the 2017 LRFD Bridge Construction Specifications 4th Edition, Section 5. The most suitable of the listed methods for the conditions recorded in the geotechnical investigation report, or a combination of these methods, shall be used, subject to approval of the Engineer, to produce sound and durable concrete drilled shaft foundations. The permanent casing method shall be used only when required by the plans or authorized by the Engineer.

If at any time during the construction of the drilled shafts the Engineer determines that the equipment, materials, employees, or procedures are such that defects in the work may occur, the Engineer may stop the work until appropriate changes are made by the contractor. In no case shall the contractor be relieved of its responsibility for constructing acceptable drilled shaft foundations.

609-3.02 Confirmation Shafts:

Unless otherwise specified in the Special Provisions, the contractor shall construct a confirmation shaft to determine the adequacy of the contractor's equipment, materials, employees, and procedures for completion of the drilled shaft foundations in accordance with the requirements of the plans, specifications, and installation plan. Confirmation shafts may also be waived if approved in writing by the Engineer.

Unless otherwise approved by the Engineer, the confirmation shaft shall be the first drilled shaft foundation to be developed. The Engineer will specify the location of the confirmation shaft, unless shown on the plans. The confirmation shaft holes shall be completed in the same manner as other production shafts. The contractor shall revise its methods and equipment as necessary at any time during the construction of the confirmation shaft hole to satisfactorily complete the excavation. When the contractor fails to satisfactorily demonstrate the adequacy of its methods, procedures, or equipment; or when unforeseen conditions require revision, such as the need for slurry; the installation plan shall be revised and the adjacent shaft shall be designated as the confirmation shaft for the revised installation plan, as approved by the Engineer.

When shown on the plans or when directed by the Engineer in writing, the reaming of bells or development of rock sockets at specified confirmation shaft holes shall be required to establish feasibility in specific soil strata.

609-3.03 Excavation:

The contractor shall perform all excavation required for the shafts, rock sockets, or belled footings, through any material encountered, to the dimensions and elevations shown on the plans or as directed by the Engineer. Unless otherwise shown on the plans, the maximum deviation from plumb shall be not more than 1.5 percent. The maximum

permissible variation of the design center axis for both the borehole and rebar cage at the top shall be 5 percent of the shaft diameter, not to exceed 3 inches from its project plan location. The contractor shall determine plumbness by plumb lines in dry excavations and by Kelly bar position readings at 10-foot intervals in wet excavations, or as approved by the Engineer. The contractor shall provide the Engineer with the plumbness readings for each borehole to verify the plumbness requirements prior to concrete placement in the borehole. When bells or rock sockets are required, they shall be excavated so as to form a bearing area of the size and shape shown on the plans.

If suitable material is not encountered at the design tip elevation shown on the plans, the bottom of any excavated hole shall be lowered, at the direction of the Engineer. When the contractor is directed by the Engineer to excavate past the design tip elevation, the contractor shall be compensated for any additional excavation in accordance with the requirements of Subsection 109.04 of the specifications. The limits of additional excavation will be determined by the Engineer.

When the contractor accidentally excavates beyond the design tip elevation, the criteria are as follows:

(A) If suitable material was encountered due to over excavation, the contractor shall not be compensated for the additional excavation.

(B) If unsuitable material was encountered due to over excavation, the Engineer will direct the contractor to excavate past the unsuitable material; the contractor shall be compensated for the additional excavation in accordance with the requirements of Subsection 109.04 of the specifications.

The reinforcing steel cage and concrete shall not be placed in the shaft until the final excavated hole elevation has been established and the Engineer has approved the completed excavation. Modifications to the reinforcing steel cage shall be in accordance with the requirements of Subsection 609-3.06 of the specifications.

If caving conditions are encountered, no further drilling will be allowed until a construction method is employed that will prevent excessive caving and which is acceptable to the Engineer. If casing is proposed, the shell shall be clean and shall extend to the top of the drilled shaft excavation. The inside diameter of the casing shall not be less than the specified size of the shaft unless approved by the Engineer. The outside diameter of the shaft shall not exceed plan dimension by more than 6 inches unless use of telescoping casing or surface casing is allowed by the installation plan.

Adjacent shafts, unless separated by a minimum of four shaft diameters measured center to center, shall not be excavated until the concrete in the first shaft has been in place for a minimum of 48 hours.

Temporary surface casings may be used to aid shaft alignment and position, and to prevent sloughing of the top of the shaft excavation, if approved by the Engineer. Where temporary casing is used to stabilize excavations that include rock sockets, the temporary casing shall be 6 to 12 inches larger than the rock socket diameter and centered on the rock socket.

If the Engineer determines that the amount of caving is within acceptable limits and the contractor elects to drill under the same methods and procedures, the excavation shall be filled with concrete at no additional cost to the Department, regardless of the extent. Any excavation beyond the dimensions shown on the plans where casings are not used shall be filled with concrete at no additional cost to the Department.

If the use of drilling slurry is to be employed, either with or without the use of casing, the contractor shall use a method of construction which will allow completion of the drilled shaft in a continuous manner without any mixing of concrete and drilling slurry.

Material excavated from shafts and bells and not incorporated elsewhere on the project shall be disposed of by the contractor.

When the plans indicate drilled shafts are to be constructed within embankments, the embankments shall be constructed prior to drilling, except when approved otherwise by the Engineer.

After the completion of the drilled shaft excavation and prior to the placement of the reinforcing steel cage and concrete, all loose material shall be machine cleaned from the shaft. A flight auger or other equipment, as approved by the Engineer, shall be used for cleaning dry excavations where slurry or ground water is not present. Where slurry or ground water is present, the excavation shall be cleaned with a clean-out bucket or similar type of equipment, as approved by the Engineer.

After final removal of all loose material from the bottom of the excavated drill shaft hole, and prior to any concrete placement, the final shaft depths shall be measured with a weighted tape or other methods approved by the Engineer.

For all drilled shaft excavations in soils, the maximum depth of any sediment, loose, and/or disturbed material at any location at the base of the excavated hole shall not exceed 2 inches.

For wet or dry drilled shaft excavations in rock, the maximum depth of any sediment, loose and/or disturbed material at any location at the base of the excavated hole shall not exceed 1/2 inch for 50 percent of the excavated hole base area.

All open excavations shall be covered at the end of each shift in a manner approved by the Engineer.

609-3.04 Drilling Slurry:

(A) General Requirements:

The contractor is responsible to select, formulate, and implement the use of slurry to facilitate drilled shaft construction. Quality control procedures of the slurry implementation shall be detailed in the contractor's submitted installation plan. Only commercially prepared mineral slurries or polymer slurries shall be employed when slurry is used in the drilling process. Mineral slurry shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. For all slurries the percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. During construction, the level of the slurry in the shaft excavation shall be maintained at a level of 5 feet or more above the highest expected piezometric pressure head along the depth of the shaft. Unless otherwise approved in advance by the Engineer, slurry shall be injected into the excavation immediately upon encountering ground water. No further excavation shall be completed until slurry has been introduced into the shaft. In the event of a sudden significant loss of slurry to the hole, the construction of that foundation shall be stopped until either a method to stop slurry loss or an alternative construction procedure has been approved by the Engineer.

The slurry shall be premixed thoroughly with clean, fresh water. Adequate time, as prescribed by the slurry manufacturer, shall be allotted for hydration prior to introduction into the shaft excavation. Slurry tanks of adequate capacity shall be required for slurry circulation, storage, and treatment. No excavated slurry pits shall be allowed instead of slurry tanks. No mixing of slurry shall be allowed in the drilled shaft excavation. Mineral slurry shall not stand for more than four hours in the excavation without agitation. If this is not possible, excavation sidewalls shall be cleaned to remove filter cake. Mineral slurry density shall be increased by adding barite only when sodium bentonite is the mineral.

Desanding equipment shall be provided by the contractor as necessary to control mineral slurry sand content. Desanding will not be required for setting casing. The contractor shall take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include agitation, circulation, and/or adjusting the properties of the slurry. The contractor shall dispose of all mineral slurry off site at an approved disposal site.

(B) Slurry Inspection and Testing:

Quality control procedures for utilization of slurry shall be detailed in the contractor's submitted installation plan. The contractor shall have suitable apparatus available at the site capable of obtaining slurry samples at any depth within the drilled shaft excavation.

609-3.05 Integrity Testing:

(A) General:

Each drilled shaft foundation completed, unless otherwise noted on the project plans, shall be inspected by means of a cross-hole sonic logging (CSL) survey and a gamma-gamma logging (GGL) survey. The drilled shaft contractor shall furnish and install 2-inch (inside diameter) Schedule 80 PVC pipes for the surveys. The minimum number of PVC-pipe inspection tubes shall be equal to the diameter of the drilled shaft, measured in feet, and rounded-up to the next whole integer, but not less than four, or as specified in the plans. The inspection tubes shall be approximately evenly spaced around the inside circumference of the reinforcing steel cage, or as shown on the project plans. To account for any reinforcing cage stabilizing bars installed by the contractor, the maximum clearance from the reinforcing cage's stirrups to the test tube shall be no more than the size of the vertical reinforcement plus 1 inch. The pipes shall be joined to provide a clean, watertight, and unobstructed opening as specified in Subsection 609-3.05(B) of the specifications. If any damage to the tubes occurs during the installation they shall be repaired or replaced at no additional cost to the Department. If testing cannot be performed because of blockage of the tubes, the contractor shall core drill or otherwise determine the extent of any potential anomalies in the concrete, as approved by the Engineer, at no additional cost to the Department.

CSL and GGL testing shall be performed by a qualified subcontractor selected by the contractor and approved by the Engineer. The subcontractor shall provide the equipment meeting the minimum requirements listed herein, and shall have at least one year experience in CSL survey and GGL survey evaluation. The subcontractor performing the GGL shall provide proof that it is licensed to possess and use radioactive material in accordance with the Arizona Radiation Regulatory Agency. Recorded measurements shall be interpreted and the required reports shall be prepared and sealed by a licensed professional engineer, registered in the State of Arizona, with at least three years of experience in CSL survey and GGL survey evaluation. Resumes of proposed personnel shall be submitted to the Engineer for approval at least four weeks prior to commencement of work.

CSL tests shall be completed within two to four days after concrete placement and GGL tests shall be completed within two to seven days of concrete placement.

The CSL survey and the GGL survey requirements shall be as specified in Subsection 609-3.05(B) of the specifications. Inspection reports containing the acquired raw data, and evaluation reports, shall be provided as specified in Subsection 609-3.05(B) of the specifications. All reports shall be provided to the Engineer within three working days of test completion.

If the testing indicates the presence of anomalies, as defined herein, or the Engineer determines that construction defects may have occurred, the contractor shall conduct remedial testing and make repairs, as specified in Subsection 609-3.05(B)(6) of the specifications, at no additional cost to the Department.

Concrete volumetric charts shall be completed for each drilled shaft. A copy shall be delivered to the Engineer with the submittal of the inspection reports of the associated drilled shaft.

After the inspection of a shaft has been completed and the shaft accepted, all holes and test pipes in the shaft shall be filled with an approved grout.

(B) Testing Requirements:

(1) General:

The inspection tubes shall have a round, regular, internal diameter free of defects or obstructions, including at any pipe joints, in order to permit the free, unobstructed passage of source and receiver probes from top to bottom. The tubes shall be watertight and free from corrosion, with clean internal and external faces, to ensure passage of the probes and to ensure a good bond between the concrete and the tubes. Standard glue-on PVC couplings shall be used. No compression, rubber, or clamp fittings will be allowed. Care shall be taken during reinforcement installation operations to not damage the tubes or break the fasteners of the tubes. Before placement of concrete, pipes shall be checked to ensure they are free from blockages, bends, crimps or other impediments to the free passage of the testing probes.

Each pipe shall be fitted with a watertight shoe on the bottom and a removable cap on the top. The bottom cap of each tube shall be adequately secured such that it can withstand the hydrostatic pressure for the full depth of the shaft without water leakage. The pipes shall be securely attached to the reinforcement cage in a straight line, and in a regular, symmetrical pattern. The tubes shall be adequately secured to the reinforcing cage such that the tubes stay in position during placement of the rebar cage and concrete placement. At a minimum, the tubes shall be securely fastened to the inside of the reinforcing cage at least every 10 feet vertically. The tubes shall be as near to vertical and parallel as possible. The tubes shall extend from 1 inch above the bottom of the reinforcement cage to at least 4 feet above the shaft top, or approximately 2 feet above the top of the rebar cage if above the ground. Under no circumstance shall the tubes be allowed to rest on the bottom of the excavated hole. If the shaft top is below the ground surface, the tubes shall extend at least 2 feet above the ground surface. Joints shall not be allowed in the section(s) of tubes above ground. Any joints required to achieve full length tubes below ground shall be made watertight.

The tube tops shall be bare clean pipe with no pipe joints, level cut, and capped to keep debris out of the tubes. If the rebar cage extends above the top of the tubes, the circular or spiral tie-raps shall temporarily be cleared away from 1 foot below the tube top to approximately 3 feet above. After placement of the reinforcement cage, the tubes shall be filled with clean water as soon as possible, immediately before or within 1 hour after concrete placement. Care shall be exercised in the removal of caps or plugs from the pipes after installation so as to not apply excess torque, hammering, or other stresses which could break the bond between the tubes and the concrete.

Before the start of testing, the contractor shall:

(a) Run a 1.5 inch diameter 6 foot long rigid cylinder through the complete length of each access tube to check for tube blockage.

(b) Clean the top of the shaft. The shaft top shall serve as the reference zero depth for all cross-hole sonic and gamma-gamma testing. Therefore, the shaft top must be level and, if mud covered, be cleaned before testing.

(c) Provide proper access to the shafts so that the testing subcontractor can park their logging equipment within 2 to 3 feet of each access tube.

(d) Provide any special safety equipment required.

(e) Make sure the access tubes extend to at least 4 feet from the top of the concrete, and are capped and filled with water all the way to the top.

(f) Make sure each access tube is bare (no pipe joints), clean (grind edges and concrete residue), level cut, and capped.

(g) Provide an independent and stable source of 110 Volt, 1000-Watt power.

(h) Using a permanent pen marker, mark each access tube with the shaft designation and tube number. For example, Pier 2 Shaft 3 Tube 4 shall be denoted as P2S3 T4. By definition, Tube 1 is the northernmost tube, with other tubes referenced in a clockwise direction from Tube 1.

The contractor shall also provide documentation that the testing equipment has been calibrated and is functioning properly.

Changes from the design conditions such as: test tube lengths, shaft diameter and the as-drilled tip elevation shall be noted in the report.

(2) Requirements for CSL Tests:

The minimum equipment requirements for CSL shall be as follows:

(a) The ultrasonic source and receiver probes shall be capable of producing records with good signal amplitude and energy through uniform, good quality concrete. The probes shall be of a diameter and have cabling such that they descend freely through the 2 inch internal diameter Schedule 80 PVC pipe for the full depth of the shafts shown on the plans. Probes shall allow a generated or detected pulse within 6 inches of the bottom of the access tubes. The transmitter probe shall generate an ultrasonic pulse frequency not to exceed 40,000 Hz for drilled shafts 8 feet in diameter or less. For drilled shafts greater than 8 feet in diameter, the frequency to be used shall be determined by the manufacturer's equipment calibration guidelines and shall be approved by the Engineer prior to testing. The weight of each probe shall in all cases be sufficient to allow it to sink under its own weight in the access tubes. The probe housing shall be waterproof to at least 1.5 times the maximum depth of the testing. The receiver probe shall be of a similar size and compatible design to the transmitter probe, and be used to detect the arrival of the ultrasonic pulse generated by the transmitter probe.

(b) The depth of the probes shall be recordable with a measurement wheel or other suitable measuring device.

(c) The CSL equipment shall include a microprocessor-based system for analog to digital conversion and recording of data, for display of individual records, and for analysis of receiver responses and printing of logs.

(d) The CSL system shall have an appropriate filter for amplification of data and cable systems.

(e) Synchronized triggering of the recording system with the ultrasonic pulse shall be a feature of the CSL system.

(f) The system shall be able to indicate zero depth at the shaft top and not at the bottom of access tubes.

In addition, the system shall be able to log both from the top of the shaft to the bottom as well as from the bottom to the top.

(3) Testing Procedure Requirements for CSL Tests:

The minimum testing procedure requirements for CSL logging shall be as follows:

(a) Preparation of the tubes for CSL Tests:

All inspection tubes shall be filled with water prior to testing. During testing, the water level in any tube shall not drop below the top of the tube that is being tested.

(b) CSL Procedure:

Information on the shaft bottom and top elevations, tube lengths and position, along with construction dates, shall be provided by the contractor to the CSL logging subcontractor prior to the logging being performed.

All possible tube pairs shall be tested. The tests shall be carried out with the source and receiver probes in the same horizontal plane unless test results indicate potential defects, in which case the questionable zone shall be further evaluated with angled tests (source and receiver vertically offset in the tubes).

The electronic circuit shall be thoroughly checked. The choice of time base will be such that the “zero signal” and first arrival time are 2 to 3 divisions apart on the horizontal axis. Amplitude shall be such that the signal fills 2/3 to 3/4 of the screen vertically.

Once the slack is taken up out of the cables to provide accurate depth measurements of the logs, the probes shall be pulled simultaneously and uniformly from the bottom of the tubes over the depth wheel or other measuring device. All slack shall be taken out of the cables before the analyzer is switched on. The rate of ascent shall be the rate recommended by the equipment manufacturer. The cross-hole sonic measurements shall be taken at 2-inch intervals or less from the bottom to top of shaft.

(c) Anomaly Identification:

Anomalies in a drilled shaft shall be determined by evaluating the pulse arrival times and amplitude/energy signals. Zones where the measured sonic velocity reduction is 10 percent greater than the local mean measured sonic velocity within a 5-foot interval above and below the suspected anomalous zone shall be reported to the Engineer. In situations where a 5-foot interval is not available above and/or below the suspected anomalous zone, the local mean sonic velocity shall be

measured to the top of the shaft or the bottom of the inspection tubes. Further investigations to evaluate the extent of such anomalies may be required by the Engineer, and shall be in accordance with the requirements specified in Subsection 609-3.05(C) of the specifications.

(d) CSL Results:

A report showing the results of the completed CSL survey shall be submitted to the Engineer for each drilled shaft foundation within three working days of completion of testing. The Engineer will review the report within three working days of the contractor's submittal. The report shall include:

(i) Dates of shaft construction; shaft diameters; shaft lengths; shaft tip elevations; shaft cutoff elevations; type and size of drilling equipment; type of slurry if used; description of concrete mix; concrete placement method; shaft layout with shaft numbers.

(ii) Dates of logging; brief description of the testing equipment; identification of shaft logged; location of obstructions in PVC tubes; location of PVC couplers; calibration date, data and plot; summary of any unusual occurrences during testing; description and explanation of adjustments made to instrumentation or data (if any); identification of anomalies using the criteria described herein; delineation of affected tubes; vertical location and extent of anomalies; and estimated percentage of anomalous cross-sectional area.

(iii) The cross-hole sonic logs expressing the results in terms of velocity and pulse amplitude/energy versus depth. The cross-hole sonic logs shall be presented for each tube pair with all anomalous zones indicated on the logs.

(iv) Analyses of the initial pulse arrival time versus depth, velocity versus depth, and pulse amplitude/energy versus depth.

(v) Appropriate discussion of the results in the text of the report shall be included.

(vi) Tomography of anomalous zones.

(4) Requirements for GGL Tests:

The minimum equipment requirements for GGL shall be as follows:

(a) The gamma-gamma probe shall consist of a rigid cylinder containing a gamma particle emitting source and a gamma particle detector. The probe shall be suspended by a cable of sufficient design and length that it is safely capable of raising and lowering the gamma-gamma probe within a 2-inch internal diameter Schedule 80 PVC inspection pipe to the desired test depths;

(b) The cables affixed to the probe shall be of sufficient strength and durability to raise and lower the probe safely and at a controlled rate of speed. A winch mechanism shall be such that it does not damage the cables or compromise data collected in the test. A means of determining and recording probe depth shall be provided;

(c) The gamma particle emitting source shall be Cesium-137 in a sealed source form;

(d) The gamma-gamma probe detector shall consist of a proven method of gamma detection, such as Geiger Mueller or scintillation-based counters;

(e) The detector shall be connected to a readout device that is capable of displaying or recording counts, densities, and sampling duration or probe speed;

(f) The gamma-gamma probe shall possess a minimum density precision of 1.0 pounds per cubic foot;

(g) The gamma-gamma probe shall have a minimum radius of detection of 4.0 inches in concrete with density between 140 and 160 pounds per cubic foot. The probe shall have the capability of varying the radius of detection up to 7 inches in concrete with density between 140 and 160 pounds per cubic foot. The radius of detection is defined as one half of the center to center distance between the source and the detector. The actual radius of detection used in the test shall be subject to the approval by the Engineer; and

(h) Prior to using GGL, the contractor shall provide the Engineer with the calibration of the gamma-gamma probe and readout unit to correlate count rate and concrete density. The calibration shall not be more than one year old, and shall be performed using the same source and detector combination as that proposed for the GGL testing on the project. Furthermore, the calibration shall have been conducted in an environment (e.g., water-filled,

Schedule 80 PVC pipes) similar to the shafts being tested for the project. GGL shall not be performed until the Engineer has approved the calibration records. Upon approval, the contractor shall perform the gamma-gamma tests exactly in the manner as the calibration of the probe and readout unit was performed.

(5) Testing Procedure Requirements for GGL Tests:

The minimum testing procedure requirements for GGL shall be as follows:

(a) Preparation of GGL Access Tubes:

A GGL survey may be performed by an experienced subcontractor using inspection tubes completely filled with water only if the gamma-gamma probe has been calibrated in concrete calibration samples that contained inspection tubes filled with water, and the radius of detection and density precision calibration have been performed under water and found to be within the prescribed limits. In the event of gamma-gamma testing in water filled tubes, the water level during testing in any tube shall not drop below the top of the tube.

(b) GGL Procedure:

Information on the shaft bottom and top elevations, tube lengths and position, along with construction dates shall be provided by the contractor to the GGL subcontractor prior to the logging being performed.

The test shall be started by lowering the probe to the bottom of the access tube. When extracting the probe, the readings shall be taken at depth intervals not exceeding 1.5 inches and within the density precision of 1.0 pounds per cubic foot. The probe shall be extracted at a rate of between 8 to 10 feet per minute, and recorded.

To evaluate the repeatability of the GGL tests, the contractor shall perform one repeat log for each shaft in which GGL tests have been performed. After all the tubes in a given shaft have been GGL tested, the repeat log shall be performed in the first tube that was tested.

(c) GGL Data Analysis:

The following steps shall be used in the analysis of the GGL data:

(i) Apply the approved calibration parameters from the concrete calibration samples to the raw count readings and obtain bulk concrete densities. Verify that the data set contains no logging errors, duplicated data or skipped data points;

(ii) Determine the arithmetic mean of a set of bulk densities and record it on each log. A set shall consist of data collected from a single inspection pipe, using the same equipment, within the same time period. Data that shall not be included in the calculation of the mean density are: (1) repetitive data points collected at a single depth, (2) data collected at the top of the drilled shaft where the reading(s) were influenced by the gamma detector component exiting the shaft concrete, (3) data collected in the access tube above the top of the drilled shaft, (4) data affected by the anomalous zones of concrete, and (5) data that cause the population distribution to be statistically non-normal;

(iii) In the event that a known difference in the steel reinforcement layout (e.g., splices using overlapping bars) exists in a segment of a drilled shaft that affects the apparent mean, a separate mean shall be generated and utilized as the mean for that portion of the data;

(iv) Subtract the mean from each data point in the set to obtain a data set that reflects the variation from the mean; and

(v) Repeat the above steps for all inspection tubes contained within an individual shaft and plot and present that data as (1) a single plot from all tubes, and (2) an individual plot for each tube.

(d) GGL Standard Deviation Analysis:

The following steps shall be used in the standard deviation analysis of the GGL data:

(i) Determine the standard deviation (SD) of a compilation of bulk densities. A compilation shall consist of data collected from the test drilled shaft using the same equipment, within the same time period. Data that shall not be included in the calculation of the mean density are: (1) repetitive data points collected at a single depth, (2) data collected at the top of the drilled shaft where the reading(s) were influenced by the gamma detector component exiting the shaft concrete, (3) data collected in the access tube above the top of the drilled shaft, (4) data affected by the anomalous zones of concrete, and (5) data that cause the population distribution to be statistically non-normal;

(ii) The SD value that is used in step 3 shall be between 2.5 and 3.75 pounds per cubic foot. If the calculated value is below 2.5 pounds per cubic foot, then 2.5 pounds per cubic foot shall be used in step 3. If the calculated value is above 3.75 pounds per cubic foot, then 3.75 pounds per cubic foot shall be used in step 3; and

(iii) Multiply the value obtained for SD from the above step by -2.0 and -3.0 to obtain values of "Minus Two Standard Deviations" (-2SD) and "Minus Three Standard Deviations" (-3SD), respectively.

(e) Anomaly Identification:

Anomalies in a drilled shaft shall be determined by evaluating the data points developed by the above processes to the -3SD deviation criterion as follows:

(i) In a single inspection tube over any 0.5 foot or greater depth interval, all of the density readings have a value less than the determined value for -3SD.

(ii) In the same inspection tube identified anomalous by the above step, any data point that falls below the value for -3SD within a 1 foot vertical extent immediately above or below, then that depth shall be considered as anomalous in addition to the depth identified in the previous step.

(iii) In all inspection tubes adjacent to inspection tubes already identified as anomalous, if at least one data point within 2 feet vertically above or below the adjacent tube anomaly falls below the value for the -3SD, then the depth in that tube at which the anomaly is found is also anomalous, in addition to the depths identified in the previous two steps.

For the 3 steps above, if the data point falls within an interval of 1-foot or 2 feet from the top or bottom; the interval above shall be to the top of the shaft and the interval below shall be to the bottom of the test tubes.

(f) GGL Results:

A report showing the results of the completed GGL survey shall be submitted to the Engineer for each drilled shaft foundation within three working days of completion of testing. The Engineer shall review the

reports within three working days of the contractor's submittal. The report shall include:

(i) Dates of shaft construction; shaft diameters; shaft lengths; shaft tip elevations; shaft cutoff elevations; type and size of drilling equipment; type of slurry if used; description of concrete mix; concrete placement method; shaft layout with shaft numbers.

(ii) Dates of logging; brief description of the testing equipment; identification number of shafts logged; location of obstructions in PVC tubes; location of PVC couplers; calibration date, data and plot; summary of any unusual occurrences during testing; description and explanation of adjustments made to instrumentation or data (if any); identification of anomalies using the criteria described herein; delineation of affected tubes; vertical location and extent of anomalies; and estimated percentage of anomalous cross-sectional area.

(iii) Plots of each individual tube with the data points and the values of -2SD and -3SD. The plots shall indicate these points and values at all depths. Utilize symbols or line formats that permit lines corresponding to -2SD and -3SD to be distinguishable from data points.

(iv) Appropriate discussion of the results in the text of the report shall be included.

In all inspection tubes adjacent to inspection tubes already identified as anomalous, if at least one data point within 2 feet vertically above or below the adjacent tube anomaly falls below the value for the -3SD, then the depth in that tube at which the anomaly is found is also anomalous, in addition to the depths identified in the previous two steps.

(C) Procedures in Case of Anomaly Detection:

If the testing indicates the presence of anomalous zones, as identified by either the CSL or GGL tests in the drilled shaft foundation, the contractor shall conduct three-dimensional tomographic surveys based on CSL results of the anomalies, at no additional cost to the Department. The results of the tomographic surveys shall be presented in the form of concrete velocity images in two-dimensions (2-D) between each pair of tubes, and in three-dimensions (3-D) for the anomalous zone.

After reviewing the results of the CSL, GGL, and the tomographic surveys, the Engineer will make an assessment of the possibility of

defects, considering the impact on design and serviceability. The Engineer will either determine that no further action is required and the drilled shaft is accepted, or that further action by the contractor is required.

If the Engineer determines that further action is required to identify any possible defects in the anomalous zones, the Engineer will direct the contractor to proceed with an excavation investigation if the location of the anomaly can be reached using hand or mechanical excavation. If the Engineer determines that due to the location of the anomalies an excavation investigation is not feasible, the Engineer will direct the contractor to proceed with a concrete coring investigation or other investigative methods.

The selected investigation shall conform to the following requirements:

(1) Excavation Investigation:

The contractor shall submit an excavation investigation plan to the Engineer for review and approval in order to determine if any defects exist in the anomalous zones. The excavation investigation plan shall include equipment and methods to be used for excavation and concrete removal, the location of the excavation in the vicinity of the designated testing tubes, and provisions for replacement of earthen materials disturbed by excavation. If needed, the excavation investigation plan shall also include a shoring or confined space plan.

The excavation shall extend to a depth of 1-foot below the identified anomaly. After excavation and exposure of the anomaly, all visually deleterious or questionable material shall be removed. Mechanical tools shall be used to remove all inclusions or compromised concrete until competent concrete is encountered.

If the surface of the drilled shafts shows competent concrete, a small section in the center of the identified anomaly shall be removed to a minimum depth of one inch to demonstrate that the concrete surface is consistent with the concrete one inch into the drilled shaft surface.

If the visual inspection is inconclusive, a minimum 3 inch inside diameter core sample shall be obtained from the anomalous zone for either an additional visual inspection or a cylinder strength test. The depth of the core sample shall not exceed 10 feet below the top of the drill shaft. The core shall extend to 12 inches beyond the anomalous zones or as directed by the Engineer.

If the visual inspection or the results of the compressive strength testing indicate the concrete is not acceptable, all of the unacceptable concrete shall be removed and replaced to the limits determined by the Engineer.

(2) Concrete Coring Investigation:

The contractor shall submit a concrete coring investigation plan to the Engineer for review and approval in order to determine if any defects exist in the anomalous zones. The concrete coring investigation plan shall include the following information:

(a) Whether the contractor or a subcontractor will be performing the coring.

(b) The contractor or the subcontractor's relative experience in successfully coring concrete drilled shafts on a minimum of 3 projects.

(c) The concrete coring method and equipment to be used to drill and remove cores from the drilled shaft concrete.

A hole with a minimum size N-series core shall be advanced from the top of the shaft down to 12 inches below the anomaly. Anomalies detected at depth of less than 25 feet the contractor may elect to use common coring methods. For anomalies detected at depths below 25 feet, a wire-line coring method will be required starting from the top of the shaft to the location of the anomaly as described herein. Care should be taken when coring in order to use the core to assess the quality or compressive strength of the concrete. Cores shall be logged and labeled for use in assessing the required repairs.

Coring shall not begin until the concrete coring investigation plan has been approved by the Engineer.

The number, locations, diameter and depth of the core holes and lengths of individual core runs will be determined by the Engineer. The coring procedure shall avoid damage to the reinforcing steel.

(D) Procedures Post Anomaly Investigation:

After the contractor has performed the work in accordance with the approved investigation plan, and the results indicate that no defects exist in the anomalous zones, the contractor will be compensated for all the work performed under the approved investigation plan in accordance with the requirements specified in Subsection 104.02 of the specifications.

If the Engineer determines that defects exist in the anomalous zones, the contractor shall repair the defects per the requirements of Subsection 609-3.05(E) of the specifications.

(E) Procedures in Case of Defects:

A defect includes any voids, discontinuity, deficient concrete strength, inclusion or crack within the drilled shaft concrete that, in the opinion of the Engineer, requires further investigation, whether or not it is

subsequently determined to represent an inadequate or unsafe condition for the completed drilled shaft.

Should the Engineer determine that the anomalous zones reveal defects; the contractor shall submit a plan to repair, replace, or supplement the defective work in a format conforming to the template example forms and mitigation plans found in FHWA-NHI 18-024 Drilled Shafts: Construction Procedures and Design Methods, Geotechnical Engineering Circular No. 10; Appendix F, Drilled Shaft Acceptance: Example Forms and Mitigation Plans and in a manner approved by the Engineer. After review and acceptance by the Engineer, the contractor shall perform the work specified in the approved plan at no additional cost to the Department. The work described herein shall be performed by a contractor or subcontractor that has performed a similar procedure on a minimum of 3 projects.

609-3.06 Reinforcing Steel, Cage Construction, and Placement:

The reinforcing steel cage for the drilled shaft, consisting of longitudinal bars and spiral hooping or lateral ties shall be completely assembled and placed into the shaft as a unit. All reinforcing steel intersections shall be tied as specified herein. The reinforcing steel unit shall be placed in the shaft no sooner than two hours prior to the start of concreting operations, and shall be placed in accordance with the details shown on the plans.

If approved by the Engineer, bundling of vertical or horizontal reinforcing steel may be allowed if necessary to maintain a minimum bar spacing equal to five times the maximum nominal aggregate size of the concrete. Bundling of spiral reinforcing will not be allowed. A maximum of three bars may be bundled. Bundled vertical or horizontal steel shall be spaced uniformly. The contractor shall also make the necessary modifications, in accordance with the appropriate ACI specifications, to the splicing and tying details for the reinforcing steel, and submit these to the Engineer for approval along with the contractor's request for bundling of steel.

The reinforcing cage shall be adequately supported and anchored from the top to prevent movement from the required location during and for four hours after completion of concrete placement. If temporary casing is used, the reinforcing cage shall be supported prior to removing casing, and for four hours following removal of the casing. The rebar cage shall be kept plumb. The rebar cage shall not rest directly on the bottom of the excavation.

The minimum number of spacers shall be equal to the diameter of the drilled shaft, measured in feet, and rounded-up to the next whole integer, but not less than four. The spacers shall be approximately even spaced along the outside circumference of the reinforcing steel cage. Spacers shall be placed at a maximum vertical spacing of 15 feet. For all drilled shafts, unless otherwise shown on the plans for pedestrian bridges or

light pole and sign post foundations, the spacers shall provide for a minimum of 6 inches of concrete cover between the reinforcing steel and the excavation wall. Only smooth plastic roller spacers, with a minimum width of 1-1/2 inches approved by the Engineer will be allowed. Rollers shall be installed per the manufacturer's recommendations. In no case shall "dobies", other rectangular "blocks" or bent rebar tied to the reinforcing steel be used in the excavations.

If the shaft is lengthened by 24 inches or less under any circumstances, the reinforcement and test tubes shall not be extended.

If the shaft is lengthened by more than 24 inches per the direction of the Engineer, the reinforcement and test tubes shall be extended. The Engineer will provide details for the additional reinforcing if required. Such additional reinforcing will be paid for in accordance with Subsection 109.04 of the specifications.

If the shaft is lengthened by more than 24 inches due to over-excavation, the reinforcement and test tubes shall be extended at no additional cost to the Department. The contractor shall submit details for the additional reinforcing to the Engineer for review and approval.

The contractor shall submit a written request to the Engineer for approval of any variation from the splices for reinforcing steel specified in the contract documents.

All reinforcing cages shall be fabricated and supported to avoid damage during the lifting and placing. Any temporary bracing and supports shall be removed prior to final placement. Equipment used for lifting reinforcing cages shall have adequate capacity and boom length to lift the cage clear of the ground. Reinforcing cages shall not be dragged while being moved. Reinforcing cages shall be placed with splices in the lowest possible position within the excavation.

609-3.07 Concrete Placement:

(A) General:

The contractor shall begin placement of concrete within 24 hours after the completion of the drilled shaft excavation. All concrete shall be placed in accordance with Section 601 of the specifications and as specified herein. If slurry excavation is used, concrete shall be placed the same day the excavation is completed.

Prior to concrete placement, the contractor shall make all necessary arrangements to assure the uninterrupted delivery of concrete so that all drilled shaft foundations will be constructed without cold joints.

The elapsed time for slump loss refers to the duration between the initial mixing of concrete and the point at which the concrete's workability

reaches the minimum slump requirements per Subsection 609-2.01(D) of the specifications.

The concrete placement duration refers to an estimate of the entire duration required to fill the drill shaft with concrete. The concrete placement duration shall begin at the initial mixing of the concrete and extend through to the completion of placement of the concrete in the drilled shaft, including removal of any temporary casing that may cause the concrete to flow into the space previously occupied by the casing and transit time.

The concrete placement duration shall not exceed the elapsed time. If the concrete placement duration exceeds the elapsed time, the Engineer shall be promptly notified and the placement of the drill shaft shall continue to completion. Appropriate measures shall be taken to rectify the situation if needed. The Engineer may determine the need for further action or remedial work. Remedial measures and any additional work required shall be at no additional cost to the Department.

Tremie downpipes and pump pipes shall be made of steel; no aluminum shall be allowed. The inside diameter of the tremie pipe shall be at least 10 inches for all drilled shafts 4 feet or greater in diameter. The inside diameter of the pump pipe shall be at least 5 inches.

(B) Placement in Dry Excavations:

For placement in dry excavations, concrete may be placed by free fall except in fragile, non-cohesive soils where bottom scour is likely to occur, or where other caving conditions exist. The contractor shall prevent concrete from striking either the reinforcing cage or excavation side walls during free fall. Where free fall cannot be used, concrete shall be placed through a suitable clean downpipe.

Concrete vibration for the full height of the shaft is not necessary to achieve proper consolidation of the concrete. However, the shafts shall be vibrated in the top 10 feet. If temporary casing is used, the vibration shall occur after the casing has been removed.

To be considered a dry shaft, the maximum depth of water in the bottom of a drilled shaft excavation at the time of concrete placement shall be no more than 3 inches.

(C) Placement under Slurry or Water:

Concrete shall be placed by tremie methods or by pumping. Care shall be taken to ensure that all the fluid and suspended solids are expelled from the excavation during concrete placement. If concrete is placed by pumping, it shall be in accordance with the requirements of Subsection 601-3.03(C) of the specifications.

The contractor's installation plan shall demonstrate the procedures used to determine when the tremie pipe is to be raised during concrete placement. The procedure shall assure that the opening of the tremie pipe will be deeper than 5 feet below the surface of the concrete at all times for shaft diameters less than 6 feet, and deeper than 10 feet below the surface of the concrete for shaft diameters 6 feet and larger. A rapid raising or lowering of the tremie will not be permitted.

In order to prevent contamination of concrete placed initially, the lower end of the pump or tremie pipe shall be provided with either a valve, sealable cap, or a plug ("pig"). The discharge end shall be placed at the bottom of the excavation prior to commencement of concrete placement. If a plug is used, it shall be inserted at the top after the pipe has been set in place. Concrete shall then be placed by pushing the plug ahead, separating the concrete from the drilling fluid. Only when the tremie pipe is completely filled shall the open end be lifted off the bottom. The concrete flow that comes to the top of the shaft shall be displaced out of the shaft excavation in a continuous flow until clean, fresh concrete is expelled.

Slurry ejected during concrete placement may be reused provided that it is screened to remove gravel chips or other granular materials, and providing the slurry meets acceptance criteria. Slurry to be discarded shall be disposed of in a manner approved by the Engineer.

Concrete placed under slurry or water shall not be vibrated, except that the top 5 feet of the shaft shall be vibrated after the slurry or water and contaminated concrete have been totally expelled from the shaft. If temporary casing is used, the vibration shall occur after the casing has been removed.

609-3.08 Casing Removal:

During removal of any casing, a sufficient head of not less than 10 feet of fluid concrete in the tremie pipe shall be maintained above the level of concrete in the shaft (outside the tremie pipe), except at the top of the shaft. All contaminated concrete shall be removed from the shaft. Temporary casings shall be removed while the concrete slump is a minimum of 4 inches. The contractor shall maintain a minimum 5-foot head of concrete for shaft diameters of less than 6 feet, and a minimum 10-foot head of concrete for shaft diameters 6 feet or greater, in the casing as it is being removed. Movement of the casing by exerting upward pressure and tapping to facilitate extraction, or extraction with a vibratory hammer will be permitted. Casing extraction shall be at a slow, uniform rate with the force in-line with the shaft axis. The removal method shall prevent the intrusion of water, grout, and soil into the excavation, displacement of the reinforcing steel, and lifting of the concrete.

Due care shall be exercised to prevent upward movement of the shaft concrete and reinforcing steel during casing extraction. Upward movement beyond 1 inch, excluding movement due solely to tension on

the top anchoring system, may indicate serious concrete separation or necking problems at the bottom of the casing. The contractor shall be responsible for corrective action which may include leaving the casing in place and compensating for the loss of frictional capacity in the resulting cased zone.

609-4 Method of Measurement:

Drilled shafts will be measured to the nearest linear foot from the top elevation of the shaft to the top elevation of the rock socket stratum, if required, or to the actual bottom of the shaft, as shown on the plans, or as determined in the field by the Engineer.

Rock sockets, when specified, will be measured to the nearest linear foot from the top elevation of the rock socket stratum to the actual bottom of the shaft, as shown on the plans, or as determined in the field by the Engineer.

Bell sections will be measured by the unit for each type of foundation constructed.

609-5 Basis of Payment:

The accepted quantities of drilled shafts and rock sockets, measured as provided above, will be paid for at the contract unit price per lineal foot for the diameter designated in the bidding schedule, complete in place. Price shall include excavation and disposal of spoils; drilling slurry; metal casing; steel reinforcing; Portland cement concrete; any needed forming, curing and finishing; exposing of concrete and the subsequent repair of foundations; furnishing all materials, equipment, and labor for splicing of reinforcing steel; all labor, conduit, and equipment for CSL and GGL; and all required testing and test reports.

No additional payment will be made for metal casing that is to remain in place.

No additional payment will be made for confirmation shafts, as the costs are considered to be included in the cost of constructing the drilled shaft foundation.

Payment for belled sections will be at the contract unit price for each type of foundation constructed, including excavation and concrete beyond the diameter of the shaft.

Obstructions will be defined as either material or objects of excessive dimension, which were not recorded in the geotechnical and foundation report, either in the text or boring logs. Payment for obstructions will be made in accordance with the provisions of Subsection 109.04 of the specifications.

SECTION 610 PAINTING:

610-1 Description:

The work under this section shall consist of furnishing paint and other materials and painting concrete, structural steel, or other surfaces where shown on the plans in accordance with the requirements of the specifications. The work shall include preparation of the surfaces to be painted, the protection and drying of the paint coatings and the protection of pedestrian, vehicular or other traffic near or under the work from paint spatter and disfigurement.

610-2 Materials:

Paint shall conform to the requirements of Section 1002 of the specifications, unless otherwise specified.

610-3 Construction Requirements:

610-3.01 Weather Conditions:

Paint shall be applied only on thoroughly dry surfaces and only when the atmospheric temperature is in the range from 50 degrees F to 100 degrees F, inclusive, and when the relative humidity is at or below 75 percent. Paint shall only be applied to a surface which is at least 5 degrees F above the dew point. The surface temperature should remain above the minimum temperature specified above until the paint is thoroughly dry. Paint shall not be applied when the air is misty or when weather conditions exist which might damage the work. If fresh paint is damaged by the elements, it shall be replaced or repaired by the contractor at no additional cost to the Department. The contractor may provide suitable enclosures to permit painting during inclement weather.

610-3.02 Surface Cleaning:

(A) Metal Surfaces:

All surfaces of structural steel or other metals, except galvanized surfaces, shall be cleaned prior to painting.

All surfaces of new structural steel or other metals which are to be painted shall be blast cleaned to a near-white finish in accordance with SSPC Standard SP10, unless otherwise specified or approved in writing by the Engineer.

When repainting existing steel structures, the method of cleaning will be specified in the Special Provisions. Areas not designated for repainting which are damaged as a result of the contractor's operations shall be repaired by the contractor, at no additional cost to the Department, and as approved by the Engineer.

(1) Blast Cleaning:

All dirt, rust, old paint, mill scale, and other foreign material shall be removed from steel or other metal surfaces with an approved blast cleaning apparatus. Blast cleaning shall leave all surfaces with a dense, uniform anchor pattern or profile of 1.0 to 3.0 mils, as measured with an approved surface profile comparator or pressed film replica tape.

Abrasives used for blast cleaning shall be clean dry sand, mineral grit, steel shot, or steel grit and shall be graded to produce satisfactory results. The use of other abrasives will not be permitted unless approved in writing by the Engineer.

When blast cleaning is being performed near machinery, all journals, bearings, motors and moving parts shall be sealed against entry of abrasive dust.

Blast cleaned surfaces shall be primed or treated the same day blast cleaning is done, unless otherwise authorized by the Engineer. If cleaned surfaces rust or are contaminated with foreign material before painting is accomplished, they shall be recleaned by the contractor at no additional cost to the Department.

(2) Steam Cleaning:

All dirt, grease, loose chalky paint, and other foreign material which has accumulated on previously painted surfaces shall be removed with a steam cleaning apparatus prior to all other phases of cleaning. It is not intended that sound paint be removed by this process. After steam cleaning, any paint which has become loose, curled, lifted, or loses its bond to the preceding coat or coats shall be removed to sound paint or metal surface by the contractor at no additional cost to the Department.

A detergent shall be added to the feed water of the steam generator or applied to the surface to be cleaned. The detergent shall be of such composition and shall be added in such quantity that the specified cleaning is accomplished.

Any residue, detergent or other foreign material which may accumulate on cleaned surfaces shall be removed by flushing with fresh water.

Steam cleaning shall not be performed more than two weeks prior to starting painting operations or other phases of cleaning.

Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than 24 hours after cleaning.

(3) Hand Cleaning:

Manual or powered wire brushes, hand scraping tools, power grinders, or sandpaper shall be used to remove all dirt, loose rust, mill scale, and paint which is not firmly bonded to the surfaces.

(4) Water Blast Cleaning:

Water blast cleaning shall be done in accordance with NACE (National Association of Corrosion Engineers) Standard RP-01-72 with normal water, no additives to the water will be allowed. All areas of oil and grease on surfaces to be coated shall be hand cleaned with clean petroleum solvents. The solution of solvent and contaminates shall be wiped clean and the surfaces allowed to air dry prior to the water blast cleaning. The contractor shall not use power spray equipment or similar methods to apply the solvent. All the surfaces to be coated shall be power washed with a water pressure of not less than 2000 pounds per square inch and not greater than 5000 pounds per square inch. The water blasting equipment shall have a minimum water usage of 5 gallons per minute.

Water blast cleaning shall be performed no more than two weeks prior to the start of painting operations or other phases of cleaning.

Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case less than 24 hours after cleaning.

(B) Concrete Surfaces:

Prior to painting concrete surfaces, laitance and curing compounds shall be removed from the surface by abrasive blast cleaning in accordance with the requirements of ASTM D4259. The cleaned surface shall have a roughened, textured appearance consistent with the surrounding concrete surface.

Concrete surfaces shall be thoroughly dry and free of dust at the time the paint is to be applied. Any artificial drying procedures and methods shall be subject to approval by the Engineer.

(C) Surfaces other than Metal or Concrete:

Prior to painting any surfaces other than metal or concrete, the surface shall be in accordance with the manufacturer recommendations and as approved by the Engineer.

610-3.03 Application:

Painting shall be accomplished in a neat and professional manner.

For painting metal surfaces, paint shall normally be applied by spraying with limited use of hand brushes or rollers.

For painting concrete surfaces, the contractor shall develop an Application Plan according to the manufacturer's written recommendations. The Plan shall include:

(A) Rate of application;
(B) Number of necessary coats (minimum of two coats);
(C) Ambient air temperature;
(D) Ambient surface temperature;
(E) Application equipment;
(F) Qualification of workers;
(G) Safety and damage protection; and
(H) Proposed surface preparation.

For painting concrete surfaces, the contractor shall apply all paint applications to a test specimen or to the concrete surface, according to Application Plan, for the subsequent approval of the Engineer. The contractor shall refinish the test inspection areas to match the paint finish of the surrounding concrete surfaces.

610-3.04 Protection Against Damage:

The contractor shall provide protective devices as necessary to prevent damage to the work and to other property or persons from all cleaning and painting operations.

Paint which results in an unsightly appearance on surfaces not designated to be painted shall be removed or obliterated as approved by the Engineer.

All painted surfaces that are marred or damaged as a result of the contractor's operations shall be repaired with materials and to a condition equal to that of the paint coating specified herein.

Upon completion of all painting operations and of any other work the painted surfaces shall be thoroughly cleaned.

610-3.05 Painting:

(A) Metal Surfaces:

(1) General:

All surfaces of new metals shall be painted with one shop coat (primer) and two field coats (the intermediate coat and topcoat), unless otherwise specified.

All paints used shall be appropriately chosen from among the types described in Subsection 1002-2 of the specifications and shall conform to the requirements given therein.

The dry film thickness of the paint will be measured in place with a calibrated magnetic film thickness gauge in accordance with SSPC Standard PA2.

If the minimum dry film thickness is exceeded, it shall be limited to that which will result in uniform drying throughout the paint film.

(2) Primer:

The dry film thickness of the primer shall not be less than 2.0 mils and be sufficient to cover the blast profile pattern.

A deep profile pattern from steel shot blasting may require additional applications of primer to obtain sufficient coating of the steel surface.

After structural steel has been fabricated, blast cleaned and accepted by the Engineer, all surfaces, except metal surfaces which are to be embedded in concrete, or within 3 inches of a high strength bolted connection, shall be painted with a primer.

Structural steel which is to be welded shall not be painted before welding is complete. If it is to be welded only in the fabricating shop and subsequently erected by bolting, it shall receive one coat of primer after the shop welding is completed. Areas of structural steel to be field welded shall be masked and the remainder of the steel shall be given one coat of primer.

As soon as practicable after being accepted by the Engineer and prior to removal from the shop, machine-finished surfaces shall be coated with a rust inhibitor which can easily be removed. Surfaces of milled or finished iron and steel castings shall be painted with one coat of primer.

Erection marks for field identification of steel members and weight marks shall be painted upon surface areas previously painted with the primer.

(3) Intermediate Coat:

The intermediate coat shall be appropriately tinted to contrast with the primer. The dry film thickness of the intermediate coat shall not be less than 2.0 mils.

After erection of steel structures has been completed, including all riveting, welding, bolting, and any straightening of bent metal, all adhering rust, scale, dirt, grease, and other foreign material shall be removed as specified under Subsection 610-3.02 of the specifications. All areas where the primer is damaged or deteriorated shall be thoroughly cleaned and spot painted with the same type of paint used for the primer and to the specified dry film thickness.

When the spot painting coat is thoroughly dry, the intermediate coat shall be applied. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film.

(4) Topcoat:

All small cracks and cavities which have not become sealed in a watertight manner by the intermediate coat shall be filled before the topcoat is applied.

At the option of the contractor, the intermediate coat and the topcoat may be applied in the shop. When finished coats are applied in the shop, the contractor shall repaint all damaged or deteriorated areas in the field as directed by the Engineer.

The dry film thickness of the topcoat shall be not less than 2.0 mils.

(B) Concrete Surfaces:

When painting is specified on the plans or in the special provisions, paint conforming to the requirements of Subsection 1002-2.06 of the specifications, shall be applied to the exposed concrete surfaces tabulated below, except that sidewalks, appurtenant curbs, downdrains, and bridge deck surfaces shall be excluded.

All concrete shall be finished and cured in accordance with the requirements of the specifications prior to the application of the paint.

(1) Cast-in-Place Box Girder Bridges:

All surfaces of the superstructure, including the sides and bottoms of the box girders, shall be painted.

(2) Pre-cast I-Girder Bridges:

Bridge structures with vehicular traffic passing beneath at posted speeds of less than 55 miles per hour, or with pedestrian traffic beneath, shall be painted on all surfaces of the superstructure including both sides and bottoms of the pre-cast girders and the underside of decks.

Bridge structures with vehicular traffic passing beneath at posted speeds of 55 miles per hour or more, and with no pedestrian traffic beneath, shall be painted on all surfaces of the superstructure with the exception of the sides of the interior girders, the interior side of exterior girders, and the underside of the deck.

(3) Pre-cast Box and Slab Girder Bridges:

All surfaces of the superstructure including the sides of exterior girders and the bottom surfaces of the box or slab girder when exposed to traffic view shall be painted.

(4) Bridge Substructure and Walls:

All surfaces of bridge piers, including the pier caps and bottoms of integral pier caps, piles, columns, parapet walls and abutments, concrete retaining walls and noise barrier walls shall be painted to at least 1 foot below finished grade.

(5) Barriers:

All surfaces of bridge barriers and the sides and tops of permanent barriers not adjacent to the traveled way shall be painted.

(C) Surfaces other than Metal or Concrete:

Surfaces other than metal or concrete shall be painted as recommended by the paint manufacturer and as approved by the Engineer.

All miscellaneous steel items that are not elements of bridges, cantilever sign supports, or bridge truss sign structures, may be hand-cleaned and have the required field paint coats applied in the shop.

610-3.06 Painting Damaged Galvanized Coating:

Damaged areas of galvanized coating shall be roughened by sanding or acid treatment. The roughened areas shall be painted with two coats of zinc-rich primer, conforming to the requirements of Subsection 1002-2.02 of the specifications.

610-4 Field Adhesion Testing:

Random adhesion testing of the completed paint finish may be performed by the Department after a minimum of 30 days from the time of application.

If adhesion testing is performed, it will be done according to one or both of the following methods and shall meet the respective requirements. When testing is performed in accordance with ASTM D4541, Method E, a strength of at least 100 pounds per square inch is required. When testing is performed in accordance with ASTM D3359, Method A, a rating of 3A or higher is required.

610-5 Basis of Payment:

No measurement or payment will be made for painting as specified herein and on the plans, or for independent laboratory tests, surface preparation, and supplying samples, the cost being considered as

included in the prices paid for the various contract items of work involving painting.

SECTION 701 MAINTENANCE AND PROTECTION OF TRAFFIC:

701-1 Description:

The work under this section shall consist of providing flagging services and pilot trucks, and furnishing, installing, maintaining, moving and removing barricades, warning signs, lights, signals, cones, temporary pavement markings, and other traffic control devices to provide safe and efficient passage through and/or around the work and to protect workers in or adjacent to the work zone. The work shall be done in accordance with the requirements of Part 6 of the Manual on Uniform Traffic Control Devices (MUTCD) and the associated Arizona Department of Transportation supplement. When referred to herein, these documents will be referred to as MUTCD and associated ADOT Supplement.

The requirements of the MUTCD and associated ADOT Supplement shall be considered as the minimum standards for the protection of workers and the traveling public.

Any traffic control plan included in the project plans shall govern unless an alternate plan, acceptable to the Engineer, is submitted by the contractor. If no traffic control plan is provided or if the contractor desires to deviate from the provisions for maintaining traffic as described in this section, it shall submit to the Engineer for the approval of a proposed sequence of operations and a compatible method of maintaining traffic.

The contractor's submittal shall be prepared by an individual meeting one of the following criteria:

(A) Has successfully completed a recognized traffic control supervisor training and certification program. The traffic control supervisor training and certification provided by the American Traffic Safety Services Association (A.T.S.S.A.) or the International Municipal Signal Association (IMSA) shall be acceptable. Training and certification through other programs must be approved in advance by the Engineer. The individual's training and certification shall be current and must be valid throughout the duration of the project. In order to remain current with the Department, training and certification shall be completed or renewed at least once every four years; or

(B) Be a licensed professional engineer registered in the State of Arizona and have completed an approved traffic control supervisor training program, as specified in Subsection 108.03 of the specifications. The training shall be current and must be valid throughout the duration of the project. In order for the training to remain current with the Department, it shall be completed or renewed every four years.

The contractor shall submit proof of the proposed individual's credentials at the preconstruction conference. The contractor bears all responsibility for any such contractor-submitted traffic control plan, whether prepared by its direct employee or other individual.

The contractor's proposal shall be submitted early enough to allow at least two weeks for review and approval before use of the proposed traffic control plan.

The traffic control and safety plan of the contractor, along with the contractor's work schedule and actual operations, shall be such that no condition that is considered to be unsafe, in the opinion of the Engineer, shall exist. The traffic control plan shall assure that miscellaneous operations occurring throughout the work, as well as during the final stages, are adequately protected. As a result of effective planning and efficient scheduling of the type and quantity of work, the duration, degree, length, amount, size, etc., of any traffic restriction or lane closures shall be limited to that absolutely necessary to provide a safe condition for both traffic and construction personnel.

701-2 Materials (Equipment, Workers, Devices and Facilities):

701-2.01 General:

(A) Conformance:

Except as specified herein, all equipment, procedures used by workers, devices and facilities shall conform to the requirements of the MUTCD and associated ADOT Supplement.

(B) Safety:

(1) General Requirements:

All traffic control devices listed below as Category I and Category II devices shall meet the evaluation criteria for Test Level III per NCHRP (National Cooperative Highway Research Program) Report 350.

At the pre-construction conference the contractor shall submit a letter certifying that all such traffic control devices to be used on the project will meet the above-referenced criteria. The certification shall contain the following:

(a) A list of all Category I and II traffic control devices to be used on the project;

(b) The project number;

(c) A statement verifying that these devices, and their application, meet the requirements of NCHRP Report 350 Test Level III; and

(d) The name, title and signature of a person having legal authority to bind the manufacturer or supplier of the Category I and II devices. The binding authority shall be in accordance with the applicable requirements of Subsection 106.05(B) of the specifications .

If additional Category I and II devices are required at a later date, the contractor shall provide an amended certification letter to the Engineer specifying that such devices also comply with the requirements of NCHRP Report 350 Test Level III.

For all Category I and Category II devices used on the project the contractor shall also acquire or have access to reports which verify that such devices meet the above-referenced criteria. The reports shall contain the name and model of the tested traffic control devices, detailed drawings or product literature of each, and under what conditions the devices passed. The traffic control devices detailed in the report shall be the complete warning devices, including warning lights, flags, ballast and any other auxiliary attachment allowed. Reports for Category II devices are prepared by the FHWA. For Category I devices, the supplier is responsible for testing the product and providing a report which verifies that the device meets the criteria of NCHRP Report 350, Test Level III. If requested by the Engineer, the contractor shall provide copies of such reports within one working day.

(2) Category I Devices:

Category I devices are low-mass traffic control devices that will not cause an appreciable change in speed of an impacting vehicle, nor is it likely that any part of the device will intrude into the passenger compartment. The following traffic control devices will be considered Category I devices: rubber or plastic traffic cones, rubber or plastic tubular markers, single piece plastic drums, plastic or fiberglass delineators. No warning lights, signs, flags or other auxiliary devices are allowed on Category I devices. Should any of these attachments be added to a Category I device, the Category I device will be considered a Category II device. Ballast at the base, such as a rubber tire, is an acceptable attachment to Category I devices. The single piece plastic drum refers to the construction of the body of the drum exclusive of a separate base, if any.

(3) Category II Devices:

Category II devices are low-mass traffic control devices that will not cause a significant change in speed of an impacting vehicle. The following traffic control devices will be considered Category II devices: type I, II, and III barricades with or without warning lights; vertical

panels with or without warning lights; signs and sign stand (all types) with or without warning lights and/or flags; drums, other than those listed in Category I, with or without warning lights; and any Category I devices with attached warning lights.

701-2.02 Flashing Arrow Panels:

Flashing arrow panels shall conform to the requirements of the MUTCD and associated ADOT Supplement with the following additions:

Each arrow panel shall have its own independent power source. The power source shall be capable of supplying adequate continuous power for the sign operation over extended periods of time. Fuel capacity shall be such as to provide for at least 12 hours of continuous operation without refueling. Panels may be solar powered with adequate energy source to provide for at least 12 hours of continuous operation without refueling or recharging.

701-2.03 Temporary Concrete Barrier:

Temporary concrete barrier shall be precast sections conforming to the requirements of Signing and Marking Standard Drawing C-3 and Subsections 910-2 and 910-3 of the specifications.

The contractor shall provide, at the preconstruction conference, a certificate of compliance, conforming to the requirements of Subsection 106.05 of the specifications, stating that any temporary concrete barrier to be used on the project conforms to Signing and Marking Standard Drawing C-3. The contractor shall include the project number on the submittal.

701-2.04 Temporary Impact Attenuation Devices:

Temporary impact attenuation devices shall conform to the requirements of Subsections 702-2 and 702-3 of the specifications for the type of device shown on the project plans or as approved by the Engineer.

Temporary Impact attenuation devices shall also meet evaluation criteria for Test Level 3 per NCHRP (National Cooperative Highway Research Program) Report 350, or for Test Level 3 per MASH (AASHTO Manual for Assessing Safety Hardware). The contractor shall provide, at the preconstruction conference, a certificate of compliance, conforming to the requirements of Subsection 106.05 of the specifications, certifying that any temporary impact attenuation devices to be used on the project will meet the above requirement. The contractor shall include the project number on the submittal.

701-2.05 Temporary Pavement Markings:

(A) Temporary Raised Pavement Markers and Chip Seal Pavement Markers:

Temporary Pavement Markers may be Temporary Reflective Markers, Permanent Reflective Markers (used as Temporary) or Non-Reflective Markers, as required on the Project Plans or as approved by the Engineer.

Temporary Pavement Markers shall be in conformance with Standard Drawings M-19 and M-20, and Subsections 706-2 and 706-3 of the specifications, and will be included on a list of pre-approved products maintained by the Department.

Chip Seal Pavement Markers shall conform to Standard Drawing M-20. The Chip Seal marker body and cover shall be manufactured from a polyurethane material conforming to the following requirements:

	Requirement	ASTM Test Method
Specific Gravity (Min.)	1.19	D792
Hardness (Min.)	80A	D2240
Tensile Strength (Min. PSI)	4,600	D412
Ultimate Elongation (Min. %)	330	
Modulus @ 300% PSI	1,000	
Stiffness @ -20 °F (Min. PSI) 70 °F (Min. PSI)	 17,000 900	D1053
Compression Set 22 hrs. @ 70 °C	65	D395
Taber Abrasion; CS 17 wheel, Wt. Loss (mg/1000 cycles)	3	---

Reflective tape shall be metalized polycarbonate microprism retroreflective material with acrylic backing or equal. The tape shall have a minimum reflectance equal to or greater than 1,800 candelas per foot-candle per square foot at 0.10-degree observation and 0-degree entrance angles.

(B) Preformed Pavement Markings:

Preformed Pavement Markings shall be either Type II (Temporary-Removable) or III (Temporary-Nonremovable), as indicated on the project plans or as approved by the Engineer. Preformed Pavement Markings shall be in conformance with the requirements of Section 705 of the specifications and shall be included on a list of pre-approved products maintained by the Department.

701-2.06 Temporary Sign Supports:

Temporary Sign Supports may be wood, steel or aluminum, at the option of the contractor and shall be approved by the Engineer prior to installation. Wood posts shall be Southern Pine, Douglas Fir or other soft wood. Wood posts need not be treated. Embedded posts shall meet the criteria established under NCHRP Report 350 for breakaway sign supports.

Angle braces will not be allowed.

701-2.07 Delineators:

Delineators shall be as shown on the plans and shall be in conformance with the Standard Drawings and Subsection 703-2 of the specifications.

701-2.08 Barricades and Other Channelizing Devices:

Type I barricades having a minimum of 270 square inches of retroreflective area facing traffic, and otherwise conforming to the MUTCD, may be used in lieu of Type II barricades in freeway or other high speed applications, unless specifically excepted in the project plans.

All sheeting for barricades and other channelizing devices shall conform to the requirements of Section 1007 of the specifications.

701-2.09 Drums:

Sheeting type for drums shall conform to the requirements for work zone devices shown in Section 1007 of the specifications.

701-3 Construction Requirements:

701-3.01 General:

The contractor shall provide for the adequate protection of all vehicular and pedestrian traffic and workers through any portion of the work where construction operations interfere with, obstruct, or create a hazard to the movement of traffic.

At the pre-construction conference, the contractor shall provide the Engineer with the name of the contractor's employee who is responsible for implementing, monitoring, and altering, as necessary, the traffic control plan. The Engineer will then advise the local law enforcement agency having jurisdiction, of the names of the contractor's representative and a representative of the Department who will act in a similar capacity. The contractor's designee shall be available at any time to respond to calls involving damage or displacement to barricades,

lights, signs and other devices resulting from vandalism, traffic accident or other causes.

If, at any time, the Engineer determines that sufficient traffic control is not being provided or maintained, the Engineer may order suspension of the work until the proper level of traffic control is achieved. In cases of serious or willful disregard for safety of the public or workers by the contractor, the Engineer may proceed to place the traffic control measures in proper condition and deduct the cost thereof from monies due or becoming due the contractor.

All contractor's personnel, equipment, machinery, tools and supplies shall be kept clear of active traffic lanes, except as necessary for the prosecution of the work. The contractor shall promptly remove any material or debris that is spilled or tracked onto the traveled roadway as a result of the prosecution of the work at no additional cost to the Department. Materials, vehicles and parked equipment shall be kept as far from the traveled way as practical. The contractor shall not park equipment or store materials within 30 feet of the edge of a traveled way unless an adequate barrier is present. Equipment may be parked and materials may be stored in the right-of-way only at locations approved by the Engineer.

Any devices provided under this section which are lost, stolen, destroyed or are deemed unacceptable by the Engineer, while their use is required on the project, shall be replaced by the contractor and, except as hereinafter specified for temporary impact attenuators, at no additional cost to the Department. All such devices shall be replaced by the end of the work shift unless otherwise specified.

The Engineer shall be sole judge as to which signs may require embedded posts, portable stands or another type of support.

701-3.02 Maintenance and Protection of Traffic:

All traffic control devices necessary for the first stage of construction shall be properly placed and in operation before any construction is allowed to start. When work of a progressive nature is involved, such as resurfacing a roadway under traffic, the necessary devices shall be moved concurrently with the advancing operation. The use of temporary devices shall not be extended beyond the anticipated duration of one work shift's production.

All traffic control devices shall be kept clean and free from dirt, mud, and roadway grime. Scratches, rips and tears in reflective sheeting, or loss of fluorescence in fluorescent prismatic sheeting, as determined by the Engineer, shall be promptly corrected by the contractor.

Temporary pavement markings shall be applied in conjunction with changes in the traffic pattern. Placement of new pavement markings and removal of old markings shall be done immediately when the need

for each arises. Temporary markings and devices shall be removed and new roadway marking shall be completed within 24 hours after any changes in traffic pattern unless otherwise directed by the Engineer. Obliteration of the temporary pavement markings shall be in conformance with Subsection 701-3.06 of the specifications.

Types of barricades, supports or devices not specifically described in the MUTCD and associated ADOT Supplement, but which would cause a hazard to traffic if used by the contractor, will not be permitted in the work area. The methods used by a contractor to control traffic when there are no details included in the contract, shall produce a safe condition for travel to the maximum extent possible at all times.

701-3.03 Temporary Concrete Barriers:

Barriers shall be installed in accordance with the details and at the locations shown on the project plans or where directed by the Engineer. Sections of temporary barrier shall be fastened together as shown on the Standard Drawings to form a continuous chain. After placement, each unit shall be moved longitudinally to remove slack in the joints between the units. Where shown on the project plans or directed by the Engineer, the ends of the barrier run shall be flared back or fitted with an impact attenuation device. Attenuation devices shall be installed in accordance with the requirements of Subsection 701-3.04 of the specifications.

Barrier Markers shall be installed as shown on the project plans or standard drawings.

Any unit which has been excessively damaged, as determined by the Engineer, shall not be used. Any unit damaged during or after installation shall be replaced with an undamaged unit by the close of that work shift, at no additional cost to the Department.

Temporary Glare Screen shall be installed on barriers at locations shown on plans, and on barriers used to separate opposing traffic on freeway construction contracts in urban areas. When barrier is used on freeway construction to separate traffic from construction operations, glare screen may be required when construction activity is continuous for at least 1,500 feet adjacent to the active traffic lanes.

Temporary Glare Screen shall be expanded metal or plastic attached to the barrier by a method satisfactory to the Engineer. Temporary Glare Screen shall have the following characteristics:

(A) When hit, the device shall not penetrate the passenger compartment of the errant vehicle or present a hazard to workers and other traffic;

(B) The device shall perform in a predictable manner when hit;

(C) The device shall effectively reduce glare from oncoming vehicle head lights; and

(D) The device shall be resistant to vandalism and vehicle damage, and shall be easy to repair.

701-3.04 Temporary Impact Attenuation Devices:

Energy absorbing terminals be installed at the locations in accordance to the details shown on the project plans and the manufacturer's instructions.

Devices that are damaged by the traveling public shall be repaired within 36 hours by the contractor utilizing a replacement parts package, which shall be on the job site whenever this system is in use. The replacement parts package supplied by the contractor shall be the one recommended by the manufacturer of the attenuation device in use. Upon completion of the work for which energy absorbing terminals are required, all temporary terminals used during the project and the associated replacement parts packages shall be carefully removed and stockpiled by the contractor within the limits of the project at a location specified by the Engineer and shall become the property of the Department.

Sand barrel crash cushions conforming to the requirements of Subsection 702-2.03 of the specifications shall be placed in accordance with the details shown on the project plans.

Crash cushions damaged by the traveling public shall be removed and disposed of by the contractor. New devices shall be furnished and installed by the contractor. The contractor shall repair any damaged installations within 36 hours. Sand barrel crash cushions will remain the property of the contractor upon completion of temporary use unless permanently incorporated into the project.

Upon approval of the Engineer, undamaged attenuation devices, sand barrels or metal type, may be used for permanent installation in accordance with the requirements of Subsections 702-2 and 702-3 of the specifications.

701-3.05 Temporary Pavement Markings (Application and Removal):

(A) General:

Application of temporary pavement markings shall conform to the requirements of Subsection 708-3 of the specifications, the MUTCD and associated ADOT Supplement, and other provisions of these specifications as applicable. Placement of new markings shall be done immediately when the need for each arises, in conjunction with changes in the traffic pattern.

Pavement Markings may be required by the Engineer in lieu of barricades for temporary delineation when the duration of use as shown in the traffic control plan may exceed five days or when lane widths are less than 12 feet.

(B) Raised Pavement Markers:

The adhesive shall be applied uniformly to the cleaned pavement surface and the raised pavement marker shall be placed in the correct position on the adhesive area with the application of pressure as specified by the manufacturer.

(C) Preformed Pavement Markings:

Preformed pavement markings for temporary applications shall be Type II (Temporary-Removable) and III (Temporary-Nonremovable) and shall conform to the requirements of Section 705 of the specifications.

Preformed Pavement Markings, Type II, shall only be used on surfaces or finish pavement courses where eventual removal will be required.

Preformed Pavement Markings, Type III, shall only be used where removal of markings is not required due to obliteration, abandonment or overlaying the pavement surface.

701-3.06 Obliteration of Existing Pavement Markings:

Pavement marking obliteration shall be accomplished by the contractor as indicated on the plans or as directed by the Engineer.

Pavement markings shall be removed to the fullest extent possible from the pavement by any method that does not materially damage the surface, color, or texture of the usable pavement. Abrasive blasting, using air or water, is an acceptable method for removing pavement markings, however, other methods may be approved by the Engineer. Overpainting of markings with paint or asphalt will not be permitted.

Sand or other material deposited on the pavement as a result of removing pavement markings shall be removed as the work progresses. Accumulations of sand or other material, which might interfere with drainage or might constitute conditions adverse to traffic safety, shall be removed by the contractor.

Where blast cleaning is used for the removal of pavement markings or for removal of objectionable material, the residue, including dust, shall be removed immediately after contact between the sand and the surface being treated. Such removal shall be by a vacuum attachment operating concurrently with the blast cleaning operation, or by other methods approved by the Engineer. Blast cleaning shall not be used within 12 feet of a lane occupied by public traffic unless a suitable barrier separates traffic from the area being cleaned.

Obliteration or removal of raised pavement markers shall include removal of the marker and adhesive pad, or adhesive pad alone if the marker is missing.

Any damage to the pavement caused by pavement marking removal shall be repaired by methods acceptable to the Engineer. When asphalt slurry is used to repair damage to the pavement caused by pavement marking removal or the obliteration of the marks remaining after the markings have been removed, the asphalt slurry shall be placed parallel to the new direction of travel and shall be at least 2 feet in width.

If obliteration of lead-based striping is necessary, it shall be accomplished by a method that is in compliance with 29 CFR, Lead Exposure in Construction, Interim Final Rule. If lead exposure prevention measures are required, the contractor shall ensure that all contractor personnel, subcontractors, and ADOT personnel present on the job site are notified of the activity and advised of precautions necessary to avoid contamination by lead compounds. The contractor shall submit a lead exposure plan to the Engineer for review at least 48 hours prior to the start of any striping obliteration activities. Payment for additional work to remove lead-based striping shall be in accordance with Subsections 104.02 or 109.04 of the specifications.

701-3.07 Truck-Mounted and Trailer-Mounted Attenuators:

The contractor shall provide trucks and truck-mounted attenuators, or trailer-mounted attenuators and host vehicles, at the locations shown on the project plans and/or as directed by the Engineer.

Attenuators shall meet either NCHRP Report 350, Test Level 3 criteria, or MASH (Manual for Assessing Safety Hardware), Test Level 3 criteria, passing both mandatory and optional tests. The truck and attenuator combination shall only be used in the configuration tested. Either the truck or attenuator shall have a sequential arrow display panel or changeable message board.

Attenuators that require chocking or blocking of the vehicle to meet NCHRP Report 350 or MASH certification shall not be used.

Attenuators shall have rear-mounted, retroreflective chevron stripes and a standard trailer lighting system, including brake lights, turn signals, ICC-bar lights, and two yellow rotating beacons, strobe lights, or LED lights mounted on opposite rear corners of the truck or attenuator approximately 4-1/2 feet above the bottom of the tires. A Type C arrow panel or changeable message board shall be provided and shall be installed in accordance with the NCHRP 350/ MASH Crashworthiness Certification or FHWA Letter of Acceptance. There shall be a minimum of 7 feet from the roadway to the bottom of the panel or board. Frame work shall be an integral part of the truck and be permanently mounted in such a way as to prevent the unit from separating from the truck in the case of a collision.

For each proposed truck-mounted or trailer-mounted attenuator, the contractor shall provide a Certificate of Compliance, in accordance with Subsection 106.05 of the specifications, to the Engineer for approval prior to use. For truck-mounted attenuators, the certificate shall also include the certified weigh bill for the truck, and for trailer-mounted attenuators the certificate shall state the minimum weight for the host vehicle. The certificate shall state that the attenuator meets the specified criteria, and shall clearly state the roll-ahead distance. When trucks require ballasting to comply with NCHRP 350/MASH Crashworthiness Certifications, the contractor shall provide a letter from the owner supplying the attenuator and truck stating that the ballast is in compliance with the manufacturer's recommendations and that it is anchored to the truck frame. The letter shall be on the supplier's official company letterhead and shall include:

(A) The current name, address, and phone number of the supplier of the attenuator;

(B) A statement that the individual signing the letter has the legal authority to bind the supplier;

(C) The name, title and signature of the responsible individual; and

(D) The date of the signature.

A copy of the Certificate of Compliance and if required, the letter regarding ballast shall be kept in the truck cab or host vehicle, available for immediate inspection when requested by the Engineer.

When in use for attenuation, trucks shall be used exclusively for attenuators. When in use for attenuation, such trucks shall not be used to carry or store equipment or devices, secured or unsecured. No modification in configuration or use shall be allowed without a resubmitted certified weigh bill for the Engineer's approval.

Truck-mounted or trailer-mounted attenuators used as shadow vehicles per the MUTCD shall be positioned at a distance greater than the roll-ahead distance in advance of the workers or equipment being protected so that there will be sufficient distance, but not so much that errant vehicles will travel around the shadow vehicle and strike the protected workers and/or equipment.

The contractor shall cease operations when a truck-mounted or trailer-mounted attenuator is damaged. The contractor shall not resume operations until the attenuator has been repaired or replaced, unless authorized by the Engineer.

701-3.08 Changeable Message Board:

Changeable message boards shall be furnished and maintained by the contractor at the locations shown on the plans and as specified by the Engineer. The operations and messages programmed into the board controller shall be as directed by the Engineer. The changeable message board shall be a complete and operational portable unit which shall consist of a wheeled trailer with an adjustable, changeable message board, board message controller and self-contained power supply.

The power supply for the changeable message board shall be a fully independent self-contained trailer-mounted system. The changeable message board power supply shall be battery operated and rechargeable from a solar panel mounted above the changeable message board.

The message characters shall be delineated by either electromagnetically actuated reflective dots or optically enhanced light emitting diode pixels (LED) operating under the control of a digital computer.

The contractor shall submit, at the pre-construction conference, a Certificate of Compliance that the changeable message board to be used on this project shall be as described herein.

The character formation system and components shall conform to the following requirements:

(A) The changeable message board shall be programmable, and shall be capable of displaying a minimum of three lines of message copy, with a minimum of eight characters per line, in various alphanumeric combinations;

(B) The changeable message board matrix configuration shall be 35 dots or pixels per character in a 5 horizontal by 7 vertical arrangement of the dots or pixels;

(C) The dot or pixel size shall be a 2.5-inch high by 1.625-inch wide rectangle (minimum), or equivalent area;

(D) Each character shall be 18 inches in height and 12 inches in width (minimum);

(E) The horizontal character separation shall be 3 inches or more;

(F) Dot color shall be fluorescent yellow upon activation and flat black when not activated. The LED pixels shall emit amber light upon activation and be dark when not activated;

(G) The line separation shall be 5 to 12 inches;

(H) Changeable message boards shall be protected with a clear lexan-type or equivalent shield that shall not interfere with or diminish the visibility of the sign message;

(I) The programmable message board shall be capable of displaying moving arrow patterns as one of the operator-selected programs;

(J) The message board shall also be capable of displaying up to two messages in sequence, with variable timing in a minimum of quarter-second increments;

(K) The message board shall be clearly visible and legible from a distance of 800 feet under both day and night conditions. The dot-matrix board shall have an internal illumination system that shall automatically activate under low light conditions to achieve the visibility requirements. The LED-pixel matrix board shall adjust light output (pulse width modulation) to achieve the visibility requirements; and

(L) The power supply achieved from the battery and solar panel recharging system shall have sufficient capacity to operate the changeable message board for a minimum of 20 days without direct sunshine. The solar panel array shall be capable of recharging the batteries such that 2.5 to 3.5 hours of direct sunshine shall provide for a minimum of one 24-hour period of usage. Additionally, the battery recharging controller shall have an ambient temperature sensing device which will automatically adjust the voltage supplied from the solar panels to the batteries. The sensing device shall ensure that the batteries are properly charged in hot or cold weather and shall provide the sign with sufficient power to operate the sign as specified.

When in operation, the changeable message board trailer shall be offset a minimum of 8 feet from the nearest edge of pavement. If the trailer is located behind temporary concrete barrier, a minimum offset of 6 feet will be required. Should the specified shoulder width not be available, a minimum 2-foot offset from the nearest edge of pavement or temporary concrete barrier shall be required. When positioned on the highway, the changeable message board trailer shall be delineated with a minimum of 10 Type II barricades or vertical panels with Type C steady burn lights at a spacing of 10 to 20 feet, or as shown on the approved traffic control plan.

When not in operation, the changeable message board shall be moved a minimum of 30 feet from the edge of pavement.

The changeable message board trailer shall be placed on a level surface and be secured as recommended by the manufacturer and as directed by the Engineer. The contractor shall provide any necessary incidental grading and clearing work required to provide a level surface and clear area for the sign.

701-3.09 Chip Seal Pavement Marker:

Chip Seal Pavement Markers and covers shall be located and placed on the asphaltic concrete prior to any work being started on the chip seal coat, all in a manner as approved by the Engineer.

Immediately after application of the chip seal coat to the roadway pavement, the plastic covers shall be removed, exposing the reflective tape surfaces.

Chip Seal Pavement Markers that are damaged by the contractor shall be replaced by the contractor at no additional cost to the Department.

701-3.10 Sign Sheetings:

Sign sheeting for all temporary work zone signs shall conform to the requirements of Section 1007 of the specifications.

701-3.11 Temporary Removal or Covering of Signs:

Where existing signs are not applicable during construction, they shall be removed or have the affected legends covered in place. Unless otherwise stated in the plans, or if a discrepancy exists, the Engineer will approve the method or methods to be used.

Removed signs shall be properly shipped, stored, and handled in accordance with the manufacturer's recommendations and in a manner approved by the Engineer to assure that such signs will continue to be suitable upon reinstallation.

Where temporary removal of a sign or legend is not practical, the sign face may be covered with an opaque porous cloth or fiber material, folded over the sign edges, and secured at the rear of the sign in such a manner that the sign shall not be damaged.

Tape, hardware, ropes, cables, etc., used to secure the covering material shall not touch, place any pressure on, or damage the sign face.

The covering shall be maintained by the contractor until the Engineer directs reactivation of the sign by removal of the coverings or the contract ends.

The contractor shall restore the signs and legends to their previous conditions, as directed by the Engineer. The contractor shall repair any

damage to the signs or shall replace the damaged signs, as directed by the Engineer when damage is the result of the contractor's operations.

701-3.12 Temporary Sign Supports:

Temporary Sign supports installed in the ground shall be removed at the completion of the project, the post holes filled and compacted, and the immediate area restored to match the surrounding area.

701-3.13 Flagging Services:

Flagging services shall consist of 1) Department of Public Safety (DPS) officers with agency vehicles, 2) local enforcement officers with agency vehicles, 3) local enforcement officers without agency vehicles, and 4) civilian flaggers. Local enforcement officers and DPS officers include those who meet the requirements of a Peace Officer under ARS Title 38, generally including anyone certified by the Arizona Peace Officer and Training Board. If available, DPS officers shall be used on Interstate Highways and Urban Freeways. Local enforcement officers will include uniformed officers from local police, tribal police, sheriff departments, or any other agencies that meet the requirements of a Peace Officer under ARS Title 38, generally including anyone certified by the Arizona Peace Officer and Training Board. An agency vehicle is defined as an agency-issued vehicle that meets the requirements of ARS Title 28. If local enforcement officers do not have access to an agency vehicle, a personal vehicle may be used, but it shall have a make and model similar in appearance of an agency vehicle, and shall be equipped with front and rear-facing red and blue lights. The personal vehicle, when applicable, shall be presented to the Engineer for acceptability prior to its use on the project by local enforcement officers. Approval of the personal vehicle will be at the sole discretion of the Engineer.

The contractor shall be responsible to procure DPS officers, local enforcement officers, and civilian flaggers. The Engineer will determine the types and the number of hours of flaggers as needed based on the project needs. Quantities shown on the traffic control plans and/or bidding schedule are approximate only and prepared for bidding purposes. When procuring DPS officers and local enforcement officers, the contractor shall contact the relevant agency at least two days, excluding weekends and holidays, before flagging services will be required. Such contact must be made between the hours of 7:00 A.M. and 5:00 P.M. (M.S.T.).

In the event that local enforcement officers or DPS officers are temporarily unable to provide flagging services, the contractor shall ensure that traffic control is maintained and all personnel are protected, either by providing civilian flaggers or through other means as approved by the Engineer. No adjustments to the contract will be allowed for any delays resulting from the unavailability of local enforcement officers or DPS officers.

Local enforcement and DPS officers shall not work more than 12 consecutive hour work shift without the permission of the State Construction Engineer unless an emergency situation exists which, in the opinion of the Engineer, requires that the officer remain in the capacity of a flagger.

The contractor shall furnish verification to the Engineer that all civilian flaggers have completed a recognized training and certification program. Flaggers certified by the American Traffic Safety Services Association (A.T.S.S.A.) or by the National Safety Council shall be acceptable. Certification through other programs offering flagger training may be allowed upon by the State Construction Engineer's approval. Flagger certification must be current and updated at least once every four years.

701-4 Method of Measurement:

701-4.01 General:

The Department will reimburse the contractor for the work of maintaining and protecting traffic on the basis of unit bid prices for the various Elements of Work. No additional measurement for payment to the contractor will be made for any Elements of Work other than those listed in the bidding schedule.

Elements of Work specified under this subsection which are lost, stolen, destroyed, or are deemed unacceptable by the Engineer, while in use on a project shall be replaced by the contractor and, except as hereinafter specified for temporary impact attenuators, at no additional cost to the Department.

Elements of Work will be measured for payment as follows:

(A) Elements of Work (Complete-in-Place):

The Elements of Work listed herein under Subsection 701-5 of the specifications will be measured for payment upon the satisfactory completion of the initial installation or obliteration. Except as hereinafter specified under Basis of Payment, no subsequent measurements will be made.

(B) Elements of Work (In Use):

The elements of work listed herein under Subsection 701-6 of the specifications will be measured for payment from the time at which the element is put into active use on the project and accepted by the Engineer until such time that the Engineer determines that the element is no longer required.

701-4.02 Relocation of Work Elements:

Following the initial installation of an Element of Work described above, the Engineer may direct the contractor to move the Element of Work from one location and reinstall it at another location. Except as specified elsewhere herein, in Subsection 701-5.01 of the specifications for Temporary Concrete Barrier (Installation and Removal), and Subsection 701-5.02 of the specifications for Temporary Impact Attenuators (Installation and Removal), no measurement for payment will be made for relocation of Work Elements.

When work of a progressive nature is involved, such as resurfacing a road under traffic, or closing a lane or lanes for work to be accomplished during a shift, no measurement for payment will be made for setting up or relocating the necessary traffic control equipment, workers, devices, facilities, signs etc., that are moved concurrently with the advancing operation, or removal at the end of a shift.

701-4.03 Payment Exceptions:

(A) Deficient Elements of Work:

Any deficiencies in the traffic control plan, devices, equipment, services, or other elements of work listed herein under Subsection 701-4.01(B) of the specifications will be brought to the attention of the contractor by the Engineer and all deficiencies shall be corrected before the close of that work shift, unless otherwise specified.

The contractor shall not be paid for those deficient Elements of Work listed herein under Subsection 701-4.01(B) of the specifications unless restored to full usefulness prior to the close of the work shift in which notice of the defect is given, or within the time limits specified in Subsection 701-3 of the specifications. Measurement for payment will not resume until the beginning of the work shift following that work shift in which those elements are restored to usefulness.

(B) Substantial Deficiencies:

For each work day or work shift during which there are, as determined by the Engineer, substantial deficiencies in the contractor's traffic control plan, devices, and/or services, no payment will be made to the contractor for any Element of Work listed herein under Subsection 701-4.01(B) of the specifications.

Measurement for payment will not resume for any Element of Work until the beginning of the work day or work shift following that work day or work shift in which all corrective measures have been performed by the contractor and approved by the Engineer.

In cases of serious or willful disregard for the safety of the public or its employees by the contractor, the Engineer may place the traffic control elements in proper condition and deduct the cost thereof from monies due or becoming due the contractor.

(C) Nondiligent Prosecution of Work:

In the event that the Engineer determines that the contractor's construction operations are not resulting in the diligent prosecution of the work under contract, no payment will be made to the contractor for the Elements of Work listed herein under Subsection 701-4.01(B) of the specifications until such time as the Engineer determines that the contractor is devoting appropriate efforts toward completion of the work. Payment will be suspended effective with the end of the work day or work shift in which written notice is issued to the contractor by the Engineer notifying the contractor of its failure to prosecute the work. Payment will resume with the beginning of the work day or work shift following that work day or work shift in which the Engineer determines that satisfactory efforts are being made by the contractor toward completion of the work. In any case, the contractor shall continue to be responsible for maintaining all barriers, attenuators, signs, lights and other traffic control devices in proper functioning condition at all times.

(D) Non-Working Periods:

Measurement for payment of the Elements of Work listed herein under Subsection 701-4.01(B) of the specifications will begin on the day they are installed in place for traffic control and direction. When the elements are not needed for traffic control, they shall be removed or covered and will not be measured unless they are required to stay on site in anticipation of future use or emergency use as determined by the Engineer. Should devices be required on site for these purposes they will be measured and paid for by the unit prices. During non-working periods such as holidays and Sundays, the elements in place and in satisfactory condition will be measured for payment on the day following such downtime. During these non-working periods the contractor shall conduct a minimum of one check per day to verify that the elements are in place and in satisfactory condition.

No payment will be made to the contractor for the Elements of Work listed herein under Subsection 701-4.01(B) of the specifications for non-working periods resulting from a suspension of work that, in the opinion of the Engineer, is due to the fault of the contractor. In any case, the contractor shall continue to be responsible for maintaining all barriers, attenuators, signs, lights and other traffic control devices in proper functioning condition at all times.

(E) Limitation of Measurement:

Elements of Work listed herein under Subsection 701-4.01(B) of the specifications that are measured on a unit per day basis will be measured for payment for each 24-hour day. Measurement will be based on the maximum number of units of the specific element of work that are in simultaneous use during any given period regardless of the length of time that the elements are in use and regardless of the number of times the elements are relocated.

Measurement will be made after the initial installation and once weekly thereafter for items in continuous use and at any other times changes are made in the use of traffic control elements listed under Subsection 701-4.01(B) of the specifications. The contractor shall notify the Engineer when any changes are made in the use or location of traffic control elements.

(F) Expiration of Contract Time:

No reimbursement will be made to the contractor for the Elements of Work listed herein under Subsection 701-4.01(B) of the specifications when they are required in association with construction work being performed after the expiration of the contract time and all approved extensions.

In any case, the contractor shall continue to be responsible for maintaining all barriers, attenuators, signs, lights and other traffic control devices in proper functioning condition at all times.

701-4.04 Measurement of Work Elements:

Measurement will be made as follows:

(A) Temporary concrete barrier will be measured by the linear foot along the center line of the uppermost surface upon its initial installation (Complete-in-Place), and upon any subsequent relocations, as defined in Subsection 701-5.01 of the specifications. Barrier will be measured by linear foot for each 24-hour day for the "In-Use" condition;

(B) Temporary Impact Attenuators, such as Sand Barrels and Energy Absorbing Terminals, will be measured by the unit for each complete sand barrel array, regardless of the number of barrels, or energy absorbing terminal upon its initial installation (Complete-in-Place) and upon any subsequent re-installations, as defined in Subsection 701-5.02 of the specifications. Temporary Impact Attenuators will be measured by the day for each 24-hour day that a temporary sand barrel array or energy absorbing terminal impact attenuator is in place and functional for the “In-Use” condition;

(C) Truck-Mounted Attenuators, including driver, and Trailer-Mounted Attenuators, including host vehicle and driver, will be measured by the day for each 24-hour day that a truck-mounted or trailer-mounted attenuator and operator are used to protect the work site;

(D) Flashing Arrow Panels will be measured by the day for each 24-hour day that each panel is in place and operating;

(E) Pilot Vehicles, including driver, will be measured by the hour for each approved hour of operation;

(F) Civilian flagging services will be measured by the hour for each hour that a civilian flagger is provided. Flagging services by DPS officers and local enforcement officers will be measured for each hour that a uniformed, off-duty DPS officer or law enforcement officer with vehicle is employed directly by the contractor as a flagger within the project limits, when authorized in advance by the Engineer. Quantities will be rounded to the nearest 0.5 hour;

Civilian, DPS, or local enforcement flagging services and traffic control devices required to permit contractors' traffic to enter safely into normal traffic within the project limits will be paid under their respective items. Flaggers required by a written local permit agreement will be measured for payment under this item. Additional civilian, DPS, or local enforcement flagging services used within the project limits shall be measured for payment under this item, subject to the approval of the Engineer;

Civilian, DPS, or local enforcement flagging services and traffic control devices used outside the project limits will be measured under their respective items. The Department will pay 50 percent of the unit bid price for such flaggers and traffic control devices used as described in this paragraph, subject to the approval of the Engineer. The project limits are defined as the construction work zone as shown on the approved traffic control plan for the specific section of highway under construction;

(G) Temporary Preformed Markings for Pavement, Types II and III, will be measured in accordance with the requirements of Subsection 705-4 of the specifications;

(H) Obliterate Pavement Marking will be measured in accordance with the requirements of Subsection 708-4 of the specifications;

(I) Changeable Message Boards will be measured by the day for each 24-hour day that the sign is utilized to maintain and control traffic;

(J) Obliterate Pavement Markers will be measured for each unit, Markers and Adhesive pad, or Adhesive pad alone where Markers are missing;

(K) Temporary Delineators and Temporary Pavement Markers will be measured as a unit for each delineator and marker furnished, utilized, and subsequently removed from the

project site. No measurement for payment will be made for delineators and markers that are furnished to replace damaged units as specified under Subsection 701-4.01 of the specifications;

(L) Vertical Panels, Barricades (Types II and III), Tubular Markers, Warning Lights (Types A, B, and C), Traffic Cones (28-inch), High-Level Flag Trees, Drums, Embedded Sign Posts, and Portable Sign Stands (Spring-Type and Rigid), will be measured as a unit for each device furnished and subsequently utilized at the project site for each 24-hour day;

Temporary Signs will be measured as Small (less than 10 square feet) and Large (10 square feet or more) regardless of sheeting type. Temporary Signs will be measured as a unit for each sign furnished and subsequently utilized at the project site for each 24-hour day. Quantities may be determined on a weekly basis for signs in continuous use;

Utilization shall be defined as including those devices ordered to remain on site or covered in accordance with Subsection 701-4.03(D) of the specifications and approved by the Engineer;

(M) Specialty Signs are signs which are required on the job, as determined by the Engineer or shown on project plans, and are not reusable as traffic control signs. Specialty Signs shall contain information which is project and location specific. The sign sheeting shall be orange fluorescent prismatic rigid sheeting unless otherwise specified, and the size, type and legend of the Specialty Signs will be determined by the Engineer, unless specified on the project plans. Specialty Signs will be measured for payment by the square foot, inclusive of borders. Any sign over 20 square feet in area shall be considered a Specialty Sign; and

(N) Obliterate Pavement Legends or Arrows will be measured by each separate symbol, arrow or legend.

701-5 Basis of Payment for Elements of Work (Complete-in-Place):

701-5.01 Temporary Concrete Barrier (Installation and Removal):

Temporary concrete barrier, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work, complete in place, as specified herein and as shown on the plans, including furnishing, placing, dismantling, and removal. The price

bid shall also include any required connection devices, barrier markers, and glare screen.

Fifty percent of the contract unit price for temporary concrete barrier will be paid upon satisfactory installation.

Should it be necessary to dismantle, pick up and relocate a portion of the barrier installation during construction, whether laterally or vertically, that portion of the removed and relocated barrier will be considered a new installation and paid for at 100 percent of the contract unit price.

Fifty percent of the contract unit price will be paid upon final removal.

No payment will be made for portions of the barrier which the contractor can adjust or realign without dismantling and picking up, such cost being considered as included in the bid price for Temporary Concrete Barrier "Installation and Removal." The Engineer will be the sole judge as to whether devices are to be dismantled, picked up and reinstalled, or are to be adjusted or realigned.

701-5.02 Temporary Impact Attenuators (Installation and Removal):

Temporary Impact Attenuation Devices shall include Sand Barrels and Energy Absorbing Terminals. Temporary Impact Attenuation Devices, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work, complete in place, as specified herein and as shown on the plans, including furnishing the devices with replacement parts, installing, removing and stockpiling the devices.

Fifty percent of the contract unit price for temporary impact attenuators will be paid upon satisfactory installation.

Should it be necessary to dismantle, pick up and reinstall attenuation devices during construction, the work of removing and reinstalling the devices will be considered a new installation and paid for at 100 percent of the contract unit bid price.

Fifty percent of the contract unit price will be paid upon final removal.

The Engineer will be the sole judge as to whether devices are to be dismantled, picked up and reinstalled or are to be adjusted or realigned. No additional payment will be made for devices which are adjusted or realigned, the cost being considered as included in the contract unit price paid for Temporary Impact Attenuator “Installation and Removal.”

Measurement and payment for furnishing materials, equipment and labor and repairing attenuation devices that are damaged by the traveling

public will be made in accordance with the requirements of Subsection 109.04 of the specifications.

No measurement or direct payment will be made for furnishing replacement parts and repairing devices damaged by other than the traveling public.

701-5.03 Temporary Preformed Markings for Pavement:

The accepted quantities of Temporary Preformed Markings, measured as provided above, will be paid for at the unit bid price for the type specified, which price shall be full compensation for the work, complete in place, including necessary pavement cleaning, and maintaining Types II and III temporary markings in construction work zones. Installation for accepted quantities shall be considered satisfactory when the markings are installed in conformance with the requirements of the plans.

When the type of temporary preformed marking is not specified, the contractor shall furnish Type II.

Additional reimbursement will be made for replacement of Temporary Markings when the contractor is required by the Engineer to install marking materials on distressed pavements or during adverse weather conditions and subsequent failure occurs. Distressed pavement conditions are defined as alligator cracking, bleeding, or spalling of bituminous pavements and spalling of PCC pavements. Adverse weather conditions are defined as any occurrence where application is required at pavement temperatures less than 50 degrees F or when precipitation occurs within 24 hours before application. The Department will pay for the replacement, where failures occur, at the unit bid price for the items. In the event a second failure occurs when markings have been reapplied on distressed pavements or under weather conditions described above, the Engineer shall determine if conditions require primer, alternate methods of marking, or reapplication of Preformed Markings. Preformed markers and markings will be paid for at the unit bid price. Primers or other methods of markings deemed necessary by the Engineer will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

701-5.04 BLANK:

701-5.05 Obliterate Pavement Marking:

Obliterate Striping, measured as provided above, will be paid for at the unit bid price per linear foot, which price shall be full compensation for the work, complete, including furnishing all labor and equipment required and restoring the pavement surface to a condition acceptable to the Engineer.

The accepted quantities of Arrows, Symbols, or Legends obliterated shall be paid for at the unit bid price for each item.

701-5.06 Temporary Pavement Markers and Chip Seal Pavement Markers:

The accepted quantities of Temporary Pavement Markers and Chip Seal Pavement Markers measured as provided above will be paid for at the unit bid price each, which price shall be full compensation for the work, complete in place, as specified herein and as shown on the plans.

701-5.07 Obliterate Pavement Markers:

Obliterate Pavement Markers will be paid for at the unit bid price each, which price shall be full compensation for the work, complete, including adhesive pad.

701-5.08 Temporary Delineators:

The accepted quantities of Temporary Delineators, measured as provided above, will be paid for at the unit bid price each, which price shall be full compensation for the work, complete, including subsequent removal as specified herein and as shown on the plans.

701-5.09 Specialty Signs:

The accepted quantities of Specialty Signs, measured as provided above, will be paid for at the unit bid price per square foot which price shall be full compensation for the work, complete in place, including manufacturing, delivery to the job site, erection and eventual removal. The price paid shall also include the cost of flags, ballasting, mountings, sign stands, and embedded posts as required.

701-5.10 Temporary Removal or Covering of Signs:

No payment will be made for Temporary Removal or Covering of Signs, including maintenance of storage facilities for the signs or sign legends and the maintenance of sign coverings, the cost being considered as included in the price of contract items.

701-6 Basis of Payment for Elements of Work (In Use):

701-6.01 Quantity Variances:

Payment for variances in quantities shall be in accordance with Subsection 104.02 of the specifications, except that, for decreases in quantities, the following items will be considered as major items:

(A) Temporary Concrete Barrier (In-Use);
(B) Barricades; and

(C) Temporary Signs.

701-6.02 Temporary Concrete Barrier (In Use):

The accepted quantities of Temporary Concrete Barrier, measured as provided above, will be paid for at the unit bid price, which price shall be full compensation for the use of the barrier installation(s), including glare screen, and for furnishing all material, equipment and labor and maintaining, realigning and adjusting the barrier installation(s), as specified herein and as shown on the plans. No payment will be made for barrier not in service, such as, barrier in stockpiled configuration awaiting phase construction change.

There will be no payment for each day that the Engineer determines the barrier traffic reflectors are not in good reflective condition, or for each day that the Engineer determines the barrier is out of alignment.

701-6.03 Channelization Devices:

(A) Vertical Panels, Barricades (Type II), Traffic Cones (28-inch), and Tubular Markers:

The accepted quantities of Vertical Panels, Barricades (Type II), Traffic Cones (28-inch), and Tubular Markers, measured as provided above, will be paid for at the unit bid price, which price shall be full compensation for the use and maintenance of each device (in-use), including labor and equipment.

Type I barricades which are substituted for Type II barricades in accordance with Subsection 701-2.08 of the specifications shall be paid for at the unit bid price for Type II barricades.

The unit bid price for barricades includes the cost of ballasting as required.

(B) Barricades (Type III) and High-Level Flag Trees:

The accepted quantities of Barricades (Type III) and High-Level Flag Trees, measured as provided above will be paid for at the unit bid price, which price shall be full compensation for the use and maintenance of each device (in-use), including labor and equipment.

The unit bid price for barricades includes the cost of ballasting and flags, as required.

When signs are to be mounted on Barricades (Type III) or High-Level Flag Trees, the signs will be paid for as Temporary Signs, Section 701-6.04 of the specifications.

(C) Drums:

The accepted quantities of Drums, measured as provided above, will be paid for at the unit bid price, which price shall be full compensation for the use and maintenance of each device (in-use), including labor and equipment.

(D) Warning Lights (Types A, B, and C):

The accepted quantities of Warning Lights (Types A, B, and C), measured as provided above, will be paid for at the unit bid price, which price shall be full compensation for the use and maintenance of each device (in-use), including labor and equipment.

(E) Embedded Sign Posts, Portable Sign Stands (Spring-Type or Rigid) and Portable Sign Posts-Barrier Mounted:

The accepted quantities of Embedded Sign Post, Portable Sign Stands (Spring-Type and Rigid) and Portable Sign Posts-Barrier Mounted, measured as provided above will be paid for at the unit bid price, which price shall be full compensation for the use and maintenance of each device (in-use), including labor and equipment.

The unit bid price for signs includes the cost of ballasting as required.

701-6.04 Temporary Signs:

The accepted quantities of Temporary Signs, measured as provided above, will be paid for at the unit bid price, which price shall be full compensation for the use and maintenance of each device (in-use), including labor and equipment.

The unit bid price for signs includes the cost of flags and ballasting as required.

No separate payment shall be made for speed plates, distance plates, or other minor sign message boards that are attached to a temporary sign, or temporary sign post, as shown on the plans. If additional signs are attached to those shown on the plans or to existing temporary sign installations, payments will be made as additional temporary signs.

701-6.05 Truck-Mounted Attenuators:

The accepted quantities of truck-mounted attenuators or trailer-mounted attenuators, measured as provided above, will be paid for at the unit bid price for truck-mounted attenuators per day of work site protection, which rate shall be full compensation for the work, complete in place, including, but not limited to, furnishing all materials; equipment; attached arrow panel or changeable message board; and labor (including the operator); and maintaining and repairing the truck and truck-mounted attenuator, or trailer-mounted attenuator and host vehicle, as specified herein and on the project plans. No adjustment to the unit bid price for

truck-mounted attenuators will be made when trailer-mounted attenuators are provided, such price being considered as full compensation for the work, as specified herein, regardless of which type of attenuator is used to protect the work site. It shall be the contractor's responsibility to replace any damaged or destroyed parts of the truck-mounted attenuator or trailer-mounted attenuator and host vehicle at no additional cost to the Department.

701-6.06 Flashing-Arrow Panels, and Changeable Message Boards:

The accepted quantity of flashing-arrow panels, measured as provided above, will be paid for at the unit bid price, which price shall be full compensation for the work, complete in place, including furnishing, operating, maintaining, and relocating the panels on the work site, and providing all necessary labor and equipment.

The accepted quantities of changeable message boards, measured as provided above, will be paid for at the unit bid price per day, which price shall be full compensation for the work, complete in place, including incidental grading; furnishing, operating, maintaining, and relocating the boards on the work site; and providing all necessary labor. Signs, sign stands, Type II barricades, or vertical panels and lights that are used to delineate changeable message boards shall be paid for at the respective unit bid prices.

701-6.07 Pilot Services and Flagging Services:

The accepted quantities of pilot vehicles, measured as provided above, will be paid for at the unit bid price for pilot vehicles with driver, which price shall be full compensation for the work, complete in place including, but not limited to, furnishing and maintaining the vehicle and furnishing the driver. Any hour worked after the eight hour regular time will be considered straight-time and will not be paid as overtime pay.

The accepted quantities of flagging services provided by the local enforcement officers (with agency vehicle), DPS officers, and civilian flaggers, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work, complete in place, including the agency vehicle. Any hour worked after the eight hour regular time will be considered straight-time and will not be paid as overtime pay.

The accepted quantities of flagging services provided by the local enforcement officers without an agency vehicle, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work complete in place. Any hour worked after the eight hour regular time will be considered straight-time and will not be paid as overtime pay. No measurement or payment will be paid for the vehicle, regardless of the type of vehicle is an agency vehicle or not, the cost being considered as included in the price of the contract item.

In addition, the Department has estimated an additional two hours of travel time per officer per day in the quantities shown in the bid schedule. However, if more than two hours of travel time per day is required, such additional hours will be compensated in accordance with the requirements of Subsection 104.02 of the specifications if approved by the State Construction Engineer. Travel time is considered to be supplementary to the hours worked by the officer during a work shift.

701-6.08 Temporary Impact Attenuators (In-Use):

The accepted quantities of temporary impact attenuators, measured as provided above, will be paid for at the unit bid price, which price shall be full compensation for the use of the complete attenuating device and for furnishing all material, equipment and labor for maintaining, realigning and adjusting the attenuator installation, as specified herein and as shown on the plans. No payment will be made for attenuators not in service, such as attenuator stockpiled for replacement parts or awaiting phase construction change.

SECTION 702 ATTENUATION DEVICES:

702-1 Description:

The work under this section shall consist of furnishing all materials and installing permanent attenuation devices of the types designated and at the locations shown and in accordance with the plans and the requirements of the specifications.

702-2 Materials:

702-2.01 General:

Materials used in the construction of the vehicular impact attenuator system shall all be new except that undamaged attenuation devices used for Maintenance and Protection of Traffic may be used for permanent installation when approved by the Engineer.

Materials used in transitions or connections between impact attenuators and metal-beam guardrail shall conform to the requirements of Section 1012 of the specifications.

Materials used in transitions or connections between impact attenuators and concrete structures or barriers shall conform to the applicable requirements of Subsection 910-2 of the specifications, except anchors and anchor bolts shall conform to the requirements of Section 1012 of the specifications.

Concrete shall be utility concrete conforming to the requirements of Section 922 of the specifications. Steel reinforcement shall conform to the requirements of Section 1003 of the specifications.

Asphaltic concrete shall conform to the requirements of Section 409 of the specifications.

Attenuation devices approved for use are shown on the Department's Approved Products List (APL). The most current version is available on the ADOT Engineering and Construction, Product Evaluation Program Website. Attenuation devices other than those listed on the APL must be approved by the Department prior to use.

702-2.02 Blank:

702-2.03 Sand Barrel Crash Cushion:

The barrels used in sand barrel crash cushions shall be frangible, plastic barrels formulated or processed to resist deterioration from ambient ultraviolet light.

The barrels shall exhibit good workmanship and shall be free of structural flaws and objectionable surface defects. When filled with the specified weight of sand, the barrel walls shall not distort, either as an indentation or a protrusion, more than 1/2 inch from the original barrel wall configuration.

Each barrel shall be clearly labelled with the design weight of the filled barrel. The barrels shall have design weights consistent with those shown on the project plans. The Engineer may open the barrels to verify fill height and weight based on manufacturer's literature.

When sand barrel crash cushions are installed at elevations above 3,000 feet, a minimum of 5 percent rock salt (by weight) shall be thoroughly mixed with the sand.

Regardless of whether barrels are pre-filled or filled in place on the project site, the Department will sample the sand or the sand/rock salt mixture.

For barrels filled in place the sand, or the sand/rock salt mixture if used, will be sampled in accordance with AASHTO R 90 and will be accepted only upon test results indicating conformance to the requirements herein. If the Department accepts the sand barrel crash cushion, a permanent unique identifier will be affixed to the barrel indicating conformance with the requirements specified herein.

Pre-filled barrels delivered to the project shall have been inspected by the Department in advance and shall each have a Department-furnished unique identifier that is permanently affixed to the barrel corresponding to a production lot(s) for which Department test results indicated

conformance with the requirements specified herein. Pre-filled barrels not having a Department-furnished unique identifier will not be accepted.

Upon delivery the contractor shall furnish a Certificate of Compliance, in accordance with the requirements of Subsection 106.05 of the specifications, for each production lot from which filled barrels are supplied. The Certificate of Compliance shall include a statement of the following:

(A) The assembly of all parts of each sand barrel, including filling of the barrels with sand or a sand/rock salt mixture, has been completed as directed by the manufacturer; and

(B) The pre-indicated fill heights have been adjusted based on the unit weight of the sand in accordance with the manufacturer's recommendations.

Barrels shall be filled to the specified weight with clean concrete sand meeting the requirements of ASTM C33 or alternatively, sand (fine aggregate) meeting the requirements of Subsection 1006-2.03(B) of the specifications. The sand, immediately prior to placement in the barrel, shall have a dry unit weight of 90 to 110 pounds per cubic foot when tested in accordance with AASHTO T 19 (Shoveling Method) and a moisture content of less than 2 percent in accordance with AASHTO T 255.

Sampling of the sand for pre-filled barrels will be performed by the Department on a production lot basis. The supplier shall notify the Department at least 10 days prior to filling barrels. A Certificate of Analysis for the sand, conforming to the requirements of Subsection 106.05 of the specifications, shall be submitted to the Department upon sampling that indicates the following:

(A) The sand meets the requirements herein for dry unit weight and conformance to ASTM C33 or Subsection 1006-2.03(B) of the specifications;

(B) The total dry weight of sand included in the production lot; and

(C) The quantity of each specified weight of barrel that will comprise the production lot.

Samples of the sand will be taken in accordance with AASHTO R 90 prior to the addition of any rock salt to determine conformance with the requirements of gradation. If the production lot will consist of sand only, the sand will also be tested for conformance with the requirements for dry unit weight and moisture content.

When a sand-rock salt mixture is used, the Department will sample, in addition to the sand, the sand-rock salt mixture in accordance with

AASHTO R 90. The sand-rock salt mixture will be tested to determine conformance with the requirements for dry unit weight, moisture content, and percent rock salt. The percent rock salt will be determined in accordance with Arizona Test Method 744.

The rock salt will be sampled to verify the maximum particle size.

The entire quantity of sand or sand-rock salt mixture intended for the production lot shall be maintained separately in a stockpile or other suitable means to prevent contamination.

The Engineer will notify the supplier of the test results. The test results will reference the Supplier, Production Date(s), Total Dry Weight of Sand, and Production Lot Number. Production lots containing at least 5 percent rock salt will be identified with an alphanumeric production lot number that includes the prefix “RS”. If the test results are not acceptable, the production lot will be rejected by the Department.

The supplier shall notify the Department’s Structural Materials Testing Section at least five days prior to filling the barrels to coordinate observation of the operation by Department’s Structural Materials Testing Section. The Department will observe the filling of the barrels and will affix a unique identifier to each barrel filled with approved materials in an acceptable manner. The unique identifier will be in the form of a stencil or green tag containing the following information: Supplier, Production Date, Specified Weight of Sand, Production Lot Number, and Lab Report Number.

Sand barrel crash cushion installations placed prior to January 1, 2017 for which test results indicate conformance with the material requirements herein will be allowed to remain in use.

Lifting, moving, and transporting of sand barrels shall be accomplished in a manner consistent with the manufacturer’s recommendations and shall not result in damage to the sand barrel or cause loss of sand from or vertical migration of sand within the barrel.

Sand barrels may be transported and used on one or more projects provided that they are properly identified, have been previously accepted by the Department and are free of defects. Any sand barrel that demonstrates evidence of tampering will not be accepted.

702-3 Construction Requirements:

Attenuation devices shall be placed at the locations shown on the project plans or as directed by the Engineer and shall conform to the details shown on the plans and the requirements of the manufacturer.

Unless otherwise specified on the project plans, the attenuation device shall be placed on a paved pad meeting thickness, slope, strength and smoothness requirements of the manufacturer, and shall be made either

of utility concrete or asphaltic concrete, at the option of the contractor. Foundation pads for permanent sand barrel arrays shall be 4-inch thick utility concrete or asphaltic concrete. The soil under the pad shall be compacted to not less than 95 percent of the maximum density found in accordance with the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. When installation of the attenuation device is complete, all trash shall be removed from its area and the soil surface around it shall be smoothed to the elevation indicated on the project plans.

Any welding required shall be performed in accordance with the requirements of the American Welding Society Structural Welding Code AWS D 1.1-80.

702-4 Method of Measurement:

Attenuation devices will be measured as a unit for each device installed, except that devices which were previously used for maintenance and protection of traffic and are being reused as a permanent installation will not be measured for payment.

702-5 Basis of Payment:

The accepted quantities of attenuation devices, measured as provided above, will be paid for at the contract unit price for the type designated in the bidding schedule, complete in place. No extra measurement or payment will be made for any concrete, reinforcing steel, hardware, fasteners, structural steel, pavement pad materials, any connection or transition section needed to connect the impact attenuator to guardrail or concrete barriers, grading in the area of the impact attenuator and required only to smooth vehicle approach paths to it, excavation and backfill required immediately adjacent to the barrier, and sand to fill crash cushion modules, as the cost thereof will be considered as included in the contract unit price for the impact attenuator, complete in place.

Labor and equipment used to remove and reinstall attenuation devices used for maintenance and protection of traffic and being reused as a permanent installation will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

SECTION 703 DELINEATORS AND MARKERS:

703-1 Description:

The work under this section shall consist of furnishing and installing delineators, reference markers, object markers, snow markers and milepost markers in conformance with the details shown on the project plans, the manufacturer's recommendations and in accordance with the requirements of these specifications.

The types of delineators and markers to be installed and the locations will be shown on the project plans.

703-2 Materials:

703-2.01 General:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for approval. Additionally, the contractor shall provide detailed manufacturer's information, specifications and application guidelines.

Flexible delineators shall be two-piece or three-piece assemblies, and shall comply with the requirements specified herein.

Two-piece flexible delineator assemblies shall consist of a hollow flexible delineator post with an integral base transition segment, and a separate foundation unit. Three-piece flexible delineator assemblies shall consist of a hollow flexible delineator post, a separate base transition unit, and a separate foundation unit. Foundation units for both assemblies shall be either a driven steel post, a steel post in a concrete foundation, or a surface-mounted unit, as called for on the plans.

The devices shall exhibit good workmanship and shall be free of burns, discoloration, cracks, or other objectionable marks which would affect appearance or serviceability.

Samples of each device shall be supplied for testing if requested by the Engineer. The Engineer and contractor shall field verify the locations, necessary lengths and quantities prior to materials being ordered. Item lengths and quantities shall be adjusted as necessary.

Flexible delineator components currently approved for use are shown on the Department's Approved Products List. Copies of the most current version are available on the internet from the ADOT Research Center, through its Product Evaluation Program.

703-2.02 Metal Posts:

Posts for delineators and for all markers, including mileposts or reference markers installed on freeways shall conform to the details shown in the project plans.

703-2.03 Concrete:

Concrete for the milepost or reference marker foundations shall be utility concrete conforming to the requirements of Section 922 of the specifications.

703-2.04 Metal Plates:

Metal plates for the various types of object markers shall conform to the details shown on the plans and shall be fabricated in one piece from 0.063-inch thick aluminum-alloy sheet 3003-H 14, 5052-H 38, or 6061-T 6, all conforming to the requirements of ASTM B209.

703-2.05 Paint:

Paint for use on the metal plates shall conform to the requirements of Section 1002 of the specifications for the type and color of paint specified on the plans.

703-2.06 Retroreflective Sheeting:

Retroreflective sheeting for markers and all delineators excluding flexible delineators shall conform to the requirements of Section 1007 of the specifications.

For flexible delineators, all reflective sheeting shall consist of a prismatic retroreflective system having a smooth outer surface, and shall conform to applicable criteria in ASTM D4956 for the type of sheeting, including class, color, specific intensity per unit area (SIA), color processing, adhesive, and artificial weathering.

All sheeting shall be applied on flexible delineators in the factory by the manufacturer. Field application of reflective sheeting on flexible delineator assemblies shall not be allowed unless approved by the Engineer. If the sheeting has been damaged in any way, the damaged flexible delineator post shall not be installed, and the contractor shall provide and install a new undamaged device at no additional cost to the Department.

Sheeting on flexible delineators assemblies shall be one 12-inch vertical by 3-inch horizontal strip of fluorescent yellow, silver-white, or red retroreflective sheeting, as called for on the plans. The reflector sheeting shall be installed at the horizontal center of the flexible delineator posts, with the top of the sheeting not more than 1 inch from the top of the post.

The type of retroreflective sheeting for markers and all delineators excluding flexible delineator to be applied shall be as specified on the plans. The reflective sheeting type to be used for all flexible delineator assemblies shall be Type IX unless noted otherwise.

703-2.07 Prismatic Reflectors:

Prismatic reflectors for delineators and markers shall conform to the requirements of Section 1008 of the specifications.

The type of prismatic reflectors to be used shall be as specified on the plans.

703-2.08 Hardware:

Steel bolts and nuts of the types shown on the plans shall be galvanized in accordance with the requirements of ASTM A153 or shall be cadmium plated in accordance with the requirements of ASTM B766.

703-2.09 Base Transition Segments for Flexible Delineators:

Base transition segments for three-piece flexible delineator assemblies shall be separate replaceable, semi-flexible or rigid, non-metallic units for installation between flexible delineator posts and foundation units. The base transition unit shall include all hardware for attaching the transition unit to the flexible delineator post. The insertion length for base transition units into the flexible delineator post shall be as specified by the manufacturer.

703-2.10 Flexible Delineator Posts:

Flexible delineator posts for two-piece assemblies shall include the integral base transition segment. For three-piece assemblies, a separate base transition segment, as specified in Subsection 703-2.09 of the specifications, shall be required between the post and foundation unit.

The flexible delineator assembly shall resist overturning, twisting and displacement from wind and impact forces.

The flexible delineator post shall be manufactured from an impact resistant material such that an installed delineator assembly can withstand ten vehicle impacts at 55 mph at temperatures of 40 degrees F or above without breakage or loss of serviceability, and straighten itself to within 5 degrees of its original orientation. Little or no damage shall be caused to the impacting vehicle. The test vehicle shall be a typical sedan. The devices shall also be capable of sustaining one wheel hit during testing at 55 mph without loss of serviceability. Both two-piece and three-piece flexible delineator assemblies shall comply with these requirements when tested with any of the allowable foundations.

The flexible delineator posts shall be pigmented throughout the entire cross-section (or entire cross-section of the outer layer of multi-layered, multi-material units) so as to produce a uniform color which is an integral part of the material. The posts shall exhibit negligible color fading after 1,000 hours of Xenon Arc Exposure (ASTM G155). The posts shall be made of durable, ultraviolet-resistant, impact-resistant, non-warping, non-metallic, polymeric materials designed for a minimum of 120 months of outdoor service life.

Two-piece and three-piece flexible delineator posts shall be sufficiently rigid to resist wilting after conditioning for a minimum of two hours at 180 degrees F ± 3 degrees F. The posts shall be conditioned for a minimum of two hours at minus 5 degrees F ± 3 degrees F in an

environmentally controlled test chamber. The testing shall be performed in the environmentally controlled chamber. The devices shall be sufficiently flexible to permit three 180-degree bends at the midpoint without cracking, and with each item straightening itself to within 5 degrees of its original orientation within 60 seconds. Both two-piece and three-piece flexible delineator assemblies shall comply with these requirements when tested with any of the specified foundations.

Flexible delineator posts shall be shop-cut to the required lengths without permanent deformation or damage to the posts. The cut ends shall be straight and true. All burrs and protruding lips from the shop-cuts shall be removed. The color of the flexible delineator post body shall be either white or near white. Each flexible delineator post shall include all hardware for attaching the flexible delineator post to the foundation unit and, if applicable, to the separate base transition segment.

703-2.11 Foundation Units for Flexible Delineators Posts:

For flexible delineators, driven and concreted foundation units shall be 12-gauge square tube perforated steel anchors as shown on the standard drawings. Concrete for concreted foundation units shall conform to the requirements of Section 922 of the specifications.

The insertion length of flexible delineator assemblies into foundation units, as shown on the standard drawings, shall be between 2.75 inches and 12 inches for installation into the steel foundation posts, and 2.75 inches ± 0.50 inches for installation into surface-mounted units. Wall thickness and dimensions shall comply with the standard drawings.

For flexible delineators, Surface-mounted foundation units shall conform to the standard drawings and shall be bolted to the pavement or attached with adhesives, as recommended by the manufacturer. Bolt-mounted units shall accommodate a minimum of four anchor bolts for attachment to the pavement. Bolts for securing surface-mounted foundation units shall be tempered steel capable of 5,000 pounds in tension. Installation of bolted units shall be as specified by the manufacturer. Surface-mounted foundation units attached with adhesives shall comply with the manufacturer's recommendations for type of adhesive and construction procedures. For surface-mounted foundations for flexible delineators, should the manufacturer not specify the installation procedures, the contractor shall propose an attachment plan to the Engineer for approval. The attachment plan shall specify the installation procedure for bolted connections or, for units attached with adhesives, the type of adhesive to be used and the application requirements. The attachment plan shall be submitted to the Engineer at least two weeks prior to installation, and shall be such that the completed delineator assembly shall comply with the testing requirements specified in Subsection 703-2.10 of the specifications.

Flexible delineators shall be attached to surface-mounted foundations in accordance with the manufacturer's requirements.

703-3 Construction Requirements:

703-3.01 Metal Posts, Plates, and Foundations:

Metal posts shall be cut and perforated to the sizes and shape shown on the plans. The finished posts shall be straight with a permissible tolerance in straightness of 1/16 inch per 3 feet of post length.

Posts on which galvanizing has been damaged in transporting, handling or erecting shall be repaired by the contractor at its expense in accordance with the requirements of Subsection 610-3.06 of the specifications.

Metal plates shall be cut to size and shape and the holes punched for mounting all in accordance with the details shown on the plans. The surfaces and edges of the plates shall be free of buckles, warps, dents, cockles, burrs, and defects resulting from fabrication.

Posts shall be set vertically to line at the locations designated on the plans. Posts, except mileposts or reference marker posts requiring concrete foundations, shall be set firmly in the ground by a method that will not bend the post or deface the top of the post. If ground conditions are such that the posts cannot be driven without damaging the posts, pilot holes shall be required. Metal plates shall be installed after the posts have been set in place.

Posts shall be placed in the ground to the depth shown on the plans.

Foundations for the milepost or reference marker posts installed on freeways shall be constructed to the details and dimensions shown on the project plans. Excavation shall conform to the requirements of Subsection 203-5.03(A) of the specifications.

Existing markers and delineators that are to remain in place and which have been damaged by the contractor shall be replaced with new ones at its expense.

703-3.02 Flexible Delineators:

When installation of flexible delineator assemblies are required, the work shall include, but not limited to, excavation, grading, and pavement repair.

The contractor shall install either a 36-inch, 42-inch, or 48-inch delineator at each location as required to conform to the height requirements specified on the standard drawings. Reflector color and installation requirements shall be as called for on the plans.

The contractor may install either two-piece or three-piece flexible delineator assemblies, unless indicated otherwise on the plans.

Flexible delineators assemblies shall be installed with driven or concreted foundation units as called for on the plans.

For areas where flexible delineators are located on asphalt or concrete pavement, as shown on the plans, surface-mounted foundation units shall be required.

Surface-mounted foundation units shall be installed only on sound, tight, unbroken pavement. Should installation of the surface-mounted foundation unit damage the pavement, the contractor shall repair the damaged pavement, as directed by the Engineer, at no additional cost to the Department. When a flexible delineator assembly is located on unstable pavement, as determined by the Engineer, the contractor shall clear the broken pavement and install a driven foundation unit, at no additional cost to the Department.

703-4 Method of Measurement:

Delineators and markers will be measured by the unit for each type of delineator and marker furnished and installed, regardless of the length of the delineator and color of the reflective sheeting.

703-5 Basis of Payment:

The accepted quantities of delineators and markers, measured as provided above, will be paid for at the contract unit price each for the type of delineator or marker designated in the bidding schedule, which price shall be full compensation for the work, complete in place, including reflective strips, as specified herein and as shown on the plans.

No measurement or payment will be made for pavement cutting and repair, the cost being considered as included in the price of contract items.

SECTION 704 THERMOPLASTIC PAVEMENT MARKINGS:

704-1 Description:

(A) General:

The work under this section shall consist of cleaning and preparing pavement surfaces and furnishing and applying either white or yellow thermoplastic reflectorized pavement markings using extrusion or ribbon dispensing devices of the required shape and thickness to the prepared pavement surface at the locations and in accordance with the details shown on the project plans, the manufacturer's specifications, and the requirements of these specifications.

(B) Profile Thermoplastic Pavement Markings:

When constrained by pavement thickness, width, condition, or structural section, profile thermoplastic pavement markings may be used as centerline and edge line rumble stripes by applying yellow and white thermoplastic lines with bumps at specified widths, thicknesses, and configurations. The thermoplastic formulations used for profile thermoplastic rumble stripes shall be specifically designed as extruded profile thermoplastic reflectorized marking systems.

704-2 Materials:

704-2.01 General Requirements:

The thermoplastic reflectorized material shall consist of a solid mixture of heat-stable resins, white or yellow pigment, inter-mixed glass beads, filler, and other materials in granular or block form specifically compounded for reflectorized pavement markings to be applied to the pavement in a molten state. The characteristics of the liquefied material shall be such that complete and even coverage of specified areas to the required thicknesses is provided by the required application method and rate. Upon cooling to normal pavement temperature, this material shall produce an adherent reflectorized marking capable of resisting deformation and wear in the roadway.

Only thermoplastic materials currently shown on the Department's Approved Products List (APL) shall be used. Copies of the most recent version of the APL are available on the ADOT Research Center Product Evaluation Program Website.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted along with precertification test results from the ADOT Central Laboratory for samples from each batch of material obtained for precertification at the production line of the manufacturer.

704-2.02 Composition:

(A) General:

The thermoplastic composition shall conform to the following requirements:

Component	Percent by Weight		Profile Thermoplastic	
	White	Yellow	White	Yellow
Binder (Min.) (Note 1)	20	20	20	20
Titanium dioxide (Min.)	10	1.75	10	---

Yellow Lead-Free Pigment (Min.)	---	1.5	---	5
Reflective glass inter-mix beads (Min.) (Note 1)	20/ M 247 T 1 & 20/ M 247 T 3	20/ M 247 T 1 & 20/ M 247 T 3	30	40
Calcium carbonate or equivalent filler (Max.)	30	36.75	31	41
Note: As described in Subsection 704-2.05(C) of the specifications, for precertification purposes, thermoplastic material will be tested for binder content and glass bead content according to ASTM D4797.				

The ingredients of the thermoplastic composition shall be thoroughly mixed and in a solid or sectionalized block, or free-flowing granular form. When heated in a melting apparatus, the material shall readily liquefy into a uniform solution. This solution shall be free from all skins, dirt, foreign objects or any other ingredient which would cause bleeding, staining, blotting, or discoloration when applied to the bituminous or concrete pavement surfaces.

The thermoplastic formulation shall utilize an alkyd binder. The alkyd binder shall consist of a mixture of synthetic resins, at least one of which is solid at room temperature, and of high-boiling-point plasticizers. At least one third of the binder composition and no less than 8 percent by weight of the entire material formulation shall be solid maleic-modified glycerol ester resin or solid maleic-modified pentaerythritol ester resin. The alkyd binder shall not contain any petroleum-based hydrocarbon resins.

(B) Reflective Glass Beads:

In addition to incorporating glass beads in the thermoplastic mix, glass beads shall be evenly applied to the surface of the molten material as specified in Subsection 704-3.02(G) of the specifications.

(C) Filler:

The filler shall be a white calcium carbonate or equivalent filler.

(D) Titanium Dioxide:

Titanium Dioxide shall conform to the requirements of ASTM D476 for Type II (92 percent).

(E) Yellow Pigment:

The yellow pigment shall be heat resistant and lead free. The type of yellow pigment shall be at the option of the manufacturer provided that the material conforms to all color requirements in a stable and durable fashion as specified herein.

704-2.03 Physical Characteristics of the Composition:

(A) General Requirements:

The thermoplastic material shall not exude fumes which are toxic, injurious, or require specialized breathing apparatus when heated to the temperature range specified by the manufacturer for application. The material shall remain stable when held for four hours at this temperature, or when subjected to four reheatings, not exceeding a total of four hours, after cooling to ambient temperature. The temperature viscosity characteristics of the plastic material shall remain constant throughout the reheatings and shall show like characteristics from batch to batch. There shall be no obvious change in color of the thermoplastic material as a result of reheating, and the color of the material shall not vary from batch to batch.

(B) Color:

The thermoplastic material, after heating for four hours ± five minutes at 425 ± 3 degrees F and cooled to 77 ± 3 degrees F, shall meet the following:

White: Daylight reflectance at 45 degrees - 0 degrees shall be 70 percent minimum.

Color shall match Federal Test Standard Number 595, color chip no. 17925.

Yellow: Daylight reflectance at 45 degrees - 0 degrees shall be 43 percent minimum.

Color shall match Federal Test Standard Number 595, color chip no. 13538.

(C) Retroreflectance:

Profile thermoplastic material used as rumble stripes shall have a minimum retroreflectance value of 200 millicandelas using 30-meter geometry with an 88.76° entrance angle and 1.05° observation angle as measured by ASTM E1710 standard method 30 days after application to the roadway surface.

(D) Softening Point:

After heating the thermoplastic material for four hours ± five minutes at 425 ± 3 degrees F and testing in accordance with ASTM D36, the thermoplastic materials shall have a softening point of 215 ± 15 degrees F.

(E) Water Absorption and Specific Gravity:

The thermoplastic material shall not exceed 0.5 percent by weight of retained water when tested in accordance with the requirements of ASTM D570.

The specific gravity of the material, as determined by AASHTO T 250, shall be between 1.85 and 2.15.

(F) Impact Resistance:

After heating the thermoplastic material for four hours ± five minutes at 425 ± 3 degrees F and forming test specimens, the impact resistance shall be not less than 10 inch-pounds when tested in accordance with AASHTO T 250.

For profile thermoplastic marking as rumble stripes, the impact resistance requires a minimum of 10-inch based on specifications. The test involves applying heat (425 degrees F for 240 mins) to samples and testing via ASTMD 256 method A (un-notched).

(G) Bond Strength:

After heating the thermoplastic material for four hours ± five minutes at 425 ± 3 degrees F, the bond strength to Portland cement concrete shall be not less than 180 pounds per square inch. The bond strength shall be determined in accordance with the procedures specified in AASHTO T 250.

(H) Abrasion Resistance:

The abrasion resistance of the thermoplastic material shall be determined by forming a representative lot of the material at a thickness of 125 mils on a 4-inch square monel panel (thickness 50 ± 1 mil), on which a suitable primer has been previously applied, and subjecting it to 200 revolutions on a Taber Abraser at 25 degrees C, using H-22 calibrated wheels weighted to 250 grams. The wearing surface shall be kept wet with distilled water throughout the test.

The maximum loss of thermoplastic material shall be from 0.4 to 0.5 grams.

(I) Cracking Resistance at Low Temperature:

After heating the thermoplastic material for four hours ± five minutes at 425 ± 3 degrees F, applying to concrete blocks, and cooling to 15 ± 3 degrees, the material shall show no cracks when observed from a distance exceeding 12 inches. Testing for low temperature crack resistance shall be in accordance with the procedures specified in AASHTO T 250.

(J) Flowability:

After heating the thermoplastic material for four hours ± five minutes at 425 ± 3 degrees F, and testing for flowability in accordance with AASHTO T 250, the white thermoplastic shall have a maximum percent residue of 18, and the yellow thermoplastic shall have maximum percent residue of 21.

(K) Yellowness Index:

The white thermoplastic material shall not exceed a yellowness index of 0.12 when tested in accordance with ASTM D4960. As described in Subsection 704-2.05(C) of the specifications, for precertification purposes, thermoplastic material will be tested for yellowness index. The material will be prepared and tested in accordance with ASTM D4960. The yellowness index will be calculated using ASTM E313.

(L) Flowability (Extended Heating):

After heating the thermoplastic material for eight ± 1/2 hours at 425 ± 3 degrees F, with stirring the last six hours, and testing for flowability in accordance with AASHTO T 250, the thermoplastic shall have a maximum percent residue of 28.

(M) Flash Point:

The thermoplastic material shall have a flash point not less than 475 degrees F, or manufacturer's specification, when tested in accordance with the requirements of ASTM D92.

(N) Storage Life:

The materials shall meet the requirements of this specification for a period of one year from the date of manufacture. The month and year of manufacture shall be clearly marked on all packages of thermoplastic material. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for this one year period. Any material which does not meet the above requirements, or which is no longer within this one year period at the time of application, shall not be used. The contractor shall replace any outdated material with material meeting the above performance and time requirements at no additional cost to the Department.

(O) Primer-Sealer:

Primer-sealers shall be used on Portland cement concrete, or existing hot mix asphaltic concrete surfaces prior to application of the thermoplastic material, and shall be applied as recommended by the thermoplastic material manufacturer. The primer-sealer shall be compounded specifically for use with the specified thermoplastic material.

Application of primer-sealer will not be required on newly placed hot-mix asphaltic concrete surfaces prior to application of the thermoplastic material.

Material provided for profile thermoplastic marking used as rumble stripes and/or re-striping shall not require the application of separate primer sealer on AR- ACFC surfaces prior to application of the thermoplastic material. The material shall be fully compatible for use on an AR-ACFC surface which is less than 60 days old.

It is the responsibility of the contractor and/or the Engineer to determine if the substrate where the installation will occur warrants the need of a primer.

(P) Color Stability:

Using accelerated weathering per ASTM G155, Cycle 1, white color stability shall be measured for no color change after 500 hours of exposure, and yellow color stability shall be measured for no color change after 1000 hours of exposure.

704-2.04 Physical Requirements for Glass Beads:

Inter-mix and drop-on reflective glass beads shall conform to the requirements of Subsection 708-2.02 of the specifications and manufacturer's requirements, except as noted herein.

The inter-mix beads shall conform to AASHTO M 247 for Type I and Type 3, and may be coated or uncoated as recommended by the manufacturer. If uncoated beads are used, the thermoplastic formulation shall be configured to minimize settling of the intermix beads when the material is heated and applied.

Drop-on beads shall conform to the gradation requirements of AASHTO M 247 for Type 1, Type 3, and Type 4. Type 4 drop-on glass beads will only be considered for use on chip seal pavement surfaces.

If recommended by the manufacturer, the drop-on beads shall have an adherence coating.

704-2.05 Precertification of Thermoplastic Material:

(A) General:

As described in Subsection 704-2.01 of the specifications, the contractor shall provide to the Engineer a Certificate of Compliance from the manufacturer and test results from the Central Laboratory for samples from each batch of material obtained for precertification at the

production line of the manufacturer. If the material fails the precertification testing by Central Laboratory, the manufacturer shall not supply any thermoplastic material represented by the failing test results to ADOT projects.

(B) Precertification Sampling:

Sampling of thermoplastic material for precertification must be for an active ADOT project. The manufacturer shall obtain a sample of thermoplastic material from each batch of production that will be shipped to an ADOT project. The manufacturer shall select three equal sized bags, representative of thermoplastic material from the batch. It is recommended that the three bags be pulled from the initial, middle, and final portions of each batch or truck load. The manufacturer shall prepare a composite 1-gallon sample from these three bags in accordance with ASTM D7307. The manufacturer shall ship the composite sample to the Central Laboratory at 1221 N. 21st Avenue Phoenix, AZ 85009, along with a Certificate of Analysis, for precertification testing. The manufacturer shall identify the thermoplastic material with the batch number, the batch quantity, the batch date, the manufacturer's name, and the product name. Such identification shall be shown on the side of the container.

(C) Central Laboratory Precertification Testing Responsibilities:

The Central Laboratory is responsible for coordinating precertification for each batch of thermoplastic material that is to be precertified.

For precertification purposes, thermoplastic material will be tested for binder content and glass bead content according to ASTM D4797. For yellowness index, the material is prepared and tested in accordance with ASTM D4960. The yellowness index will be calculated using ASTM E313.

Upon completion of testing, the Central Laboratory will provide the manufacturer with a copy of the test results for each tested batch. Typically, testing will be completed within three working days of receipt of the sample. If the material fails the precertification testing, the manufacturer shall not supply any thermoplastic material represented by the failing test results to ADOT projects.

704-3 Construction Requirements:

704-3.01 Equipment:

The equipment used to install hot applied thermoplastic material shall be constructed to provide continuous uniform heating to temperatures exceeding 400 degrees F while mixing and agitating the material. The heating mechanism of the kettle shall be equipped with a heat transfer medium consisting of oil or air. The burner flame shall not directly

contact the material vessel surface. The mixing and agitating mechanism shall be capable of thoroughly mixing the material at a rate which ensures constant uniform temperature distribution. The kettle shall be equipped with two temperature gauges: one to indicate the temperature of the oil or air heat transfer medium, and the other to indicate the temperature of the thermoplastic material. The kettle shall also be equipped with an automatic thermostatic control device that allows for positive temperature control to prevent overheating or underheating of the material.

The truck shall be equipped with high pressure air spray jets in front of the pavement marking material applicators to remove loose matter from the pavement surface where the marking material is to be applied.

Hand applicator equipment, to be used for all other roadway installations, shall be either self-contained melter application units or reservoir application units that are filled from a separate melter unit. Both types of units shall be equipped to maintain and measure the required application temperatures. The hand applicator equipment shall be sufficiently maneuverable to install symbols and legends, and curved and straight lines, both longitudinally and transversely.

The application equipment shall be so constructed as to assure continuous uniformity in the dimensions of the pavement marking. The applicator shall provide a means for cleanly cutting off square pavement markings edges and provide a method of applying "skip" and solid lane lines. The equipment shall be constructed to provide varying widths and thicknesses of pavement markings. The application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment operator shall be located in such a position as to enable full visibility of the striping apparatus.

The bead dispenser shall be capable of evenly distributing glass beads at the required application rate immediately after the application of the thermoplastic. The bead dispenser on truck-mounted units shall be equipped with an automatic cut-off which is synchronized with the cut-off of the thermoplastic material.

The heating kettle and application equipment shall meet the requirements of the National Fire Underwriters, the National Fire Protection Association, and other applicable federal, state and local authorities. Thermoplastic melting units, trucks or trailers, shall be equipped with foam-type fire extinguishers suitable for application to thermoplastic material that is at the flash point.

704-3.02 Application:

(A) Placement Locations:

Survey layout for pavement markings shall be provided in accordance with Subsection 925-3.01 of the specifications. On projects that include no-passing zones, the contactor shall coordinate with the ADOT No Passing Zone Crew as described in Subsection 925-3.01 of the specifications.

Pavement markings shall be positioned as defined on the plans and in the specifications. When it becomes necessary for proper installation, the Engineer may revise individual marking locations as necessary to accommodate the following requirements:

Marking lines shall not be placed on parallel construction or expansion joints. Longitudinal lines shall be offset to provide 2 to 4 inches of clearance from parallel construction and expansion joints unless directed otherwise by the Engineer.

Placement of symbols and legends on construction joints, expansion joints or uneven pavement surfaces shall be avoided. Where the location of construction joints, expansion joints or otherwise unsuitable surfaces conflicts with specified locations for symbols or legends, the Engineer will designate the symbol or legend location. The contractor shall identify such location conflicts for the Engineer's determination.

(B) Materials Selection and Compatibility:

All thermoplastic material, drop-on glass beads, and primer-sealer will be inspected and approved by the Engineer prior to their application. The contractor shall also provide samples of said materials if requested by the Engineer.

All materials shall be properly packaged and stored. Each container to be used on the project shall be clearly labeled to indicate the following information:

(1) Nature, type, and formulation of the material;

(2) Manufacturer, batch number, and date of manufacture; and

(3) Application requirements and constraints.

Preparation and application equipment shall be in accordance with the plans and specifications, and shall conform to the recommendations of the materials manufacturer.

Incompatible materials shall not be used together. The contractor shall not combine alkyd and hydrocarbon materials in preparation or application equipment.

(C) Equipment Inspections and Deficiencies:

The contractor shall make daily maintenance and operation inspections of all application equipment to ensure that it is operable within the requirements of the specifications. The contractor shall inform the Engineer of any equipment breakdowns, intermittent malfunctions, or other conditions that may impact the proper application of specified markings. Any equipment judged to be unsuitable by the Engineer shall be repaired or replaced.

(D) Pavement Surface:

The contractor shall remove all dirt, dust, loose surfacing materials, poorly adhered existing markings, or other detrimental material from the road surface prior to application of the thermoplastic material.

The method of cleaning the surface is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. The method of surface preparation shall also be in accordance with the recommendations of the thermoplastic material manufacturer. Loose material including all grindings and obliterated markings shall be removed from the pavement surface and disposed of properly.

When thermoplastic markings are to be applied to new Portland cement concrete pavement, any curing compound present shall be removed by means of a high-pressure water jet or sandblasting, followed by sweeping and high-pressure air spray. The curing compound shall be removed at least 2 inches beyond the entire perimeter of each marking to be installed.

At the time of application of primer-sealer and thermoplastics, the road surface shall be absolutely dry with no detectable or measurable surface or near-surface dampness. If precipitation or other surface wetting is imminent, all marking operations shall be stopped. If any surface dampness is detected during marking activities, marking operations shall be stopped until the pavement dries. If the hot-applied thermoplastic marking blisters upon application, marking operations shall be stopped until the cause, potentially including subsurface moisture, is determined and corrected.

(E) Primer Application:

On both old and new Portland cement concrete pavement, a primer-sealer shall be used if recommended by the thermoplastic manufacturer. The primer-sealer shall be applied at the manufacturer's recommended application rates prior to placing the thermoplastic material. The primer-sealer shall be allowed to set up for the manufacturer's specified cure or evaporation time, and shall be free of solvent and water when the thermoplastic is applied.

The thermoplastic material shall be applied to primed pavement surfaces within the working time specified by the primer-sealer and thermoplastic materials manufacturers. If the primed surfaces are not marked within

these time limits, the contractor shall re-prime the surfaces as required by the manufacturer at no additional cost to the Department. If an epoxy primer is used, the thermoplastic application shall be completed before the epoxy has cured.

Improper primer-sealer application may result in bond failure between the thermoplastic and the pavement surface and may cause the thermoplastic surface to pinhole or blister. Should these conditions occur, all application operations shall stop until the cause is determined and corrected. All such defective markings shall be removed and replaced at no additional cost to the Department.

(F) Pavement Temperatures:

Extruded ribbon-gun application procedures shall not be used if the wind chill factor is below 65 degrees F.

For other application procedures, the road surface temperature at the time of application shall be a minimum of 55 degrees F and rising.

If at any time during marking operations the air or pavement temperature falls below these requirements, all marking operations shall stop.

(G) Thermoplastic Application:

The thermoplastic pavement marking material shall be placed after 30 calendar days but before 60 calendar days after completion of the final pavement surface, or as directed by the Engineer.

The thermoplastic pavement marking material shall be extruded on to the pavement surface at a material temperature between 385 and 415 degrees F, depending on manufacturer's recommendations, ambient air and pavement temperatures, and the nature of the pavement surface. The contractor shall verify temperature requirements with a non-contact infrared thermometer as directed by the Engineer.

The thermoplastic material temperatures shall not exceed 450 degrees F. Material temperatures exceeding 440 degrees F shall be allowed for short periods of time; however, in no case shall the material be held for more than four hours at temperatures above 440 degrees F. Total heating time for any batch of material shall not exceed six hours. The contractor shall note in the temperature log the time when each batch of thermoplastic material is first heated. The start of heating time shall also be marked on the side of the kettle to which it applies.

Drop-on glass beads shall be mechanically deposited into the thermoplastic material immediately after the thermoplastic marking is applied, using a double drop method. One drop shall be Type 1 glass beads and the other drop shall be Type 3 glass beads. Double drop methods using all Type 1 or Type 3 beads for both drops will not be allowed. Prior to the application of thermoplastic material, the

contractor shall provide to the department, in writing, the drop-on bead mix package that includes the type of glass beads as described in AASHTO M 247 and the drop rate in pounds per 100 square feet used in each drop.

The dispensers shall evenly distribute the beads in the thermoplastic material. Glass beads shall be embedded in the surface of the thermoplastic to a depth of between 50 and 60 percent of the bead diameter. If the glass beads do not adhere to the thermoplastic marking, operations shall be stopped until the problem has been corrected.

Unless otherwise specified, all thermoplastic pavement markings shall be extruded, and shall be a minimum of 90 mils thick. The thermoplastic thickness shall be uniform and consistent throughout the total length of the marking project.

For thermoplastic measured 80 mils or less in thickness, a second application of extruded 90 mil thick thermoplastic meeting all the requirements of the specifications shall be placed over the original application.

For chip seal pavement surfaces, thermoplastic pavement markings shall be extruded and shall be a minimum of 120 mils thick. The thermoplastic thickness shall be uniform and consistent throughout the total length of the marking project. The drop-on glass beads shall be mechanically deposited into the thermoplastic material immediately after the thermoplastic marking is applied, using at a double drop method. One drop shall be Type 1 glass beads and the other drop shall be Type 3 or Type 4 glass beads. Double drop methods using only one type of glass beads for both drops will not be allowed. Prior to the application of thermoplastic material, the contractor shall provide to the department, in writing, the drop-on bead mix package that includes the type of glass beads as described in AASHTO M 247 and the drop rate in pounds per 100 square feet used in each drop.

For chip seal pavement surfaces, for thermoplastic measured 120 mils or less in thickness, a second application of extruded 80 mil thick thermoplastic meeting all the requirements of the specifications shall be placed over the original application.

The contractor shall perform periodic spot checks of thermoplastic material to verify that the required thickness has been attained.

The finished thermoplastic line shall have well defined edges and be free from waviness. Lateral deviation of the thermoplastic line shall not exceed 1 inch in 100 feet. The longitudinal deviation of a painted segment and gap shall not vary more than 6 inches in a 40-foot cycle. The actual width of line shall be within the limits specified in the following table, according to the width of line called for on the plans:

Plan Width	Actual Width

4 inches	4 to 4-1/2 inches
6 inches	6 to 7 inches
8 inches	8 to 9 inches
Over 8 inches	± 1 inch

After application and sufficient drying time, the thermoplastic marking shall show no appreciable deformation or discoloration under local traffic conditions with air and road temperatures ranging from -10 to 180 degrees F. The drying time shall be defined as the minimum elapsed time, after application, when the thermoplastic pavement markings shall have and retain the characteristics required herein, and after which normal traffic will leave no impression or imprint on the newly applied marking. When applied within a temperature range of 400 ± 15 degrees F and thickness of 0.090 inches, the material shall set to bear traffic in not more than two minutes when the air and pavement surface temperatures are approximately 50 ± 3 degrees F and not more than 10 minutes when the air and road surface temperatures are approximately 90 ± 3 degrees F. The Engineer may conduct field tests in accordance with ASTM D711 to verify actual drying times.

704-3.03 Sampling and Testing of In-Place Thermoplastic Material:

(A) Thickness Testing:

Random spot checks of the thermoplastic thickness will be made by the Engineer to ensure conformance with the required criteria. Suggested spot check procedures include the following:

Wet: Thickness can be field tested immediately after the thermoplastic marking is applied by inserting a thin, graduated machinist rule or similar instrument into the molten thermoplastic to the depth of the pavement surface. The thickness is then determined visually by noting on the scale the depth of the penetration or coating of the instrument.

Dried: Thickness can be field tested by placing a small flat sheet of metal or duct tape with a known thickness immediately ahead of the striping apparatus. After striping, remove the sample and use a suitable measuring device, such as a caliper or micrometer, to determine the thickness of the dried marking.

Thickness will be tested at a minimum of two locations, randomly selected in any given mile, using the “Dried” method. The thickness measurement includes glass beads. Thickness sampling locations do not require reapplication over the gaps created when removing tape/plate.

Thickness will be measured with a digital caliper capable of measuring to the nearest thousandth of an inch.

(B) Retroreflectance Testing:

The Department will notify the contractor 72 hours prior to testing. Retroreflectance testing will be performed every 0.2 mile, with four readings taken at each location. The four readings will be taken randomly within a 10 foot section. The average of the four readings shall be the result for that location. Should the average of these readings not meet the required retroreflectance values, a second test of four readings will be performed 50 foot forward from the failing test. The higher average value of the two tests will determine the results for that location. The Department will provide raw test results to the contractor.

Retroreflectance testing will be performed in the direction of traffic. On roadways where yellow stripes separate opposing traffic, testing is done in both directions (two locations per 0.2 miles, one in each direction).

Transverse and symbol markings will not be subject to retroreflectance testing.

Longitudinal lines less than 0.2 miles (such as 12 inch white turn lanes), regardless of length, must be tested. A single test of four readings shall be taken at the approximate midpoint of each line. Should the average of these readings not meet the required retroreflectance values, a second test of four readings will be performed at the approximate half way point between the midpoint and the end. The higher average value of the two tests will determine the results for that location.

All markings that fail to meet these minimums will require reapplication and retesting of striping materials. Reapplication shall start from the location of a passing test, across the failure area(s), to the next passing test location. For thermoplastic sections applied on asphalt determined to be deficient in retroreflectance, a second application of 80 mils shall be applied. The reapplication does not require removal of the deficient section. For thermoplastic applied on both PCCP and concrete bridge decks that are determined to be deficient in retroreflectance, the failing application shall be removed and reapplied.

Depending on the extent of failing pavement markings, it may not be practical to retest with the reflectometer. In that case, the Department may perform a visual nighttime inspection. If the striping appears as bright as or brighter than the adjacent striping that meets the required retroreflectance, the Engineer may accept the reapplication.

Should retests for the reapplication of thermoplastic pavement markings fail to meet the required minimum retroreflectance, the contractor shall remove the entire stripe down to the road surface.

(C) Verification Sampling for Composite Testing of In-Place Thermoplastic:

At the discretion of the Engineer, thermoplastic material may be sampled on the project at any time during the construction of the project for verification testing. The thermoplastic material shall be field sampled utilizing a 4-inch by 12-inch galvanized sheet metal plate during thermoplastic application. The galvanized sheet metal plate shall be sprayed with thermoplastic material without additional application of glass beads. When sampling behind a striping truck, the sample will be obtained randomly from the drop nozzle after at least 150 feet of striping has been placed. Once the sample is no longer in a molten state and has cooled sufficiently, it shall remain attached to the sampling plate and be stored in a plastic bag.

For molten samples taken in the field for verification testing, the contractor shall perform the sampling under the observation of the Engineer.

704-4 Method of Measurement:

Thermoplastic pavement longitudinal markings (i.e. edge lines, lane lines, and gore lines) and transverse markings (i.e. cross-walks, stop bars, cross hatch, chevron lines, and railroad markings) will be measured by the linear foot along the center line of the pavement marking line and will be based on a 4-inch-wide line. Measurement for striping with a plan width greater or less than the basic 4 inches as shown on the plans or directed by the Engineer will be made by the same method and then adjusted by the following factor:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

No measurement will be made of the number of linear feet of gaps in dashed lines.

Double marking lines, consisting of two 4-inch-wide stripes, will be measured as two individual marking lines. Crosswalk lines, stop bars, stop lines, gore lines, cross hatch lines, chevron lines and railroad marking transverse lines will be measured for centerline length and adjusted for widths other than 4 inches, as defined above.

Thermoplastic pavement marking symbols, such as diamonds, or single, double, or triple arrows, will be measured by each unit applied. Each pavement symbol, as shown on the plans, will be considered a unit.

Thermoplastic pavement marking legends, defined as a complete letter grouping such as "SCHOOL," "XING," "STOP," “RR,” or "ONLY.", will be measured by each unit applied. Each pavement legend, as shown on the plans, will be considered a unit.

No separate measurement or payment will be made for cleaning and preparing the pavement surface, including abrasive sweeping and high-pressure air spray, and for disposal of excess materials, cleaning fluids,

and empty material containers, the cost being considered as included in contract items.

Removal of curing compound from new Portland cement concrete pavement and the application of primer-sealer, will be measured along the centerline of the line of curing compound being removed or the line of primer-sealer being applied or by the unit each for symbols and legends, as appropriate. Measurement of a line of removal of curing compound or a line of application of primer-sealer will be based on a 4-inch wide line, and shall be measured by the linear foot, and in accordance with the items of work established in the bid schedule. Measurement for lengths of removal of curing compound or application of primer-sealer with a plan width greater than 4 inches as shown on the plans or directed by the Engineer will be made by the same method and then adjusted by the following factor:

$$\frac{\text{Plan Width (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

The plan width will include an extra 4 inches – 2 inches on each side – beyond the plan width of pavement marking and will be based on a continuous length of pavement marking lines unless indicated on the project plans.

704-5 Basis of Payment:

The accepted quantities of thermoplastic pavement markings of the type specified in the bidding schedule, measured as provided above, will be paid for at the contract unit price, complete in place, including pavement surface preparation and glass beads.

The accepted quantities for removal of curing compound from new Portland cement concrete pavement and the application of primer-sealer, measured as provided above, will be paid for at the respective contract unit prices, under the items of work established in the bid schedule.

SECTION 705 PREFORMED POLYMER PAVEMENT MARKING:

705-1 Description:

(A) General:

The work under this section shall consist of furnishing all materials, preparing the pavement surface and applying preformed reflectorized pavement marking tape, or preformed thermoplastic longitudinal edge lines, skip lines, stop lines, yield lines, cross walks, legends and symbols to the pavement in accordance with the details shown on the project plans and the requirements of the specifications.

All markings shall be reflectorized with glass beads or other retroreflective particles uniformly distributed throughout the entire cross section and bonded to the top surface of the material. All markings shall comply with the retroreflectance requirements of Subsection 705-2.05 of the specifications. When glass beads are used to reflectorize markings, the glass bead properties shall also comply with Subsection 705-2.06 of the specifications.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

A list of approved manufacturers and distributors of Type I, II, III, and IV preformed pavement marking materials is shown on the Department's Approved Product List (APL). The most recent version is available on the Department's website from the ADOT Research Center, through its Product Evaluation Program.

Preformed pavement marking tape or preformed thermoplastic longitudinal edge lines, skip lines, stop lines, yield lines, cross walks, legends, and symbols shall be limited to the following applications unless otherwise specified in the contract documents.

(B) Preformed Pavement Markings - Type I (Permanent):

Type I shall be a general purpose high durability retroreflective, pliant, polymer layer for preformed long line and short line striping, symbols, and legends to be used for final permanent pavement markings. Type I shall be capable of performing as specified herein when subjected to high traffic volumes and severe wear conditions such as repeated shear action from crossover or encroachment on edge and channelization lines, starting, stopping, and turning movements.

(C) Preformed Pavement Markings - Type II (Temporary - Removable):

Type II shall be a removable preformed retroreflective pavement marking capable of performing as temporary pavement markings for long line and short line striping, symbols, and legends for the duration of a normal construction season. It shall be a nonmetallic mixture of durable materials and shall be capable of being removed intact or in large pieces either manually or with a recommended roll up device. Type II shall be used on finished pavement surfaces where traffic control or channelization through the construction zone is temporary requiring removal prior to final pavement markings.

(D) Preformed Pavement Markings - Type III (Temporary - Nonremovable):

Type III shall be a nonremovable preformed retroreflective layer on a conformable metallic backing capable of performing as temporary long line pavement markings for the duration of a normal construction season.

Type III shall be used in construction zones where removal is unnecessary due to placement of future paving courses or where pavement will be removed, obliterated or abandoned at the completion of the project.

(E) Preformed Thermoplastic Pavement Markings – Type IV (Permanent):

Type IV shall be a high durability, retroreflective, pliant, preformed thermoplastic product to be used for final permanent symbols, legends, and short line (transverse) stripes. Type IV shall be capable of performing as specified herein when subjected to high traffic volumes and severe wear conditions.

705-2 Materials:

705-2.01 Preformed Pavement Markings - Type I (Permanent):

(A) General:

Type I preformed pavement marking material shall consist of a prefabricated white or yellow layer of specified thickness and width that shall be capable of being affixed to Portland Cement Concrete or non-bleeding bituminous pavements per the manufacturer's requirements, either on the pavement surface or, when specified on the plans, inlaid into a cutout groove. The preformed polymer layer shall be weather resistant and through normal traffic wear shall show no appreciable fading, lifting, loss of skid resistance, or shrinkage or significant tearing, roll back, or other signs of poor adhesion throughout the useful life of the marking.

The polymer layer without adhesive shall be a minimum of 0.065 inch thick. The polymer layer as supplied shall be of good appearance, free of cracks and discolorations, and the edges shall be clean-cut and well-defined. The polymer layer shall have a precoated, factory-applied pressure sensitive adhesive backing. A surface preparation primer shall also be applied if recommended by the manufacturer. Whether the adhesive is precoated or supplied separately, the adhesive shall allow the polymer layer to be repositioned on the pavement surface to which it is applied before permanently fixing it in its final position with a downward pressure.

When an Oreo-type contrast pavement marking material is to be used as shown on the plans, the entire length of the pavement marking shall have 2 inch-wide borders on each side across the width of the reflective base pavement marking (white, yellow or other color). These borders shall be non-reflective and black in color. The contrast pavement marking material, including the borders, shall conform to the requirements for durability, skid resistance, thickness, and adhesion specified in Subsection 705-2.01(C) of the specifications.

When a lead-lag type contrast pavement marking material is to be used as shown on the plans, lead-lag pavement markings shall be used only on Portland Cement Concrete pavement surfaces, or as directed by the Engineer.

All white and yellow Type I pavement markings shall be warrantied by the manufacturer to retain color and adherence to the pavement, and to retain a minimum retroreflectance of 100 millicandelas/m^2/lux for a minimum of two years for symbols, legends, and transverse pavement markings, and six years for longitudinal pavement markings. The warranty period shall begin after all pavement markings are installed and accepted by the Department. Failure to meet the specified retroreflectance on at least 90 percent of the longitudinal pavement marking in any 1000-foot segment, or 90 percent of a legend, symbol, or transverse pavement marking shall be considered a complete failure of that marking. The warranty shall state that the manufacturer will provide new material to replace defective Type I markings at no additional cost to the Department. The warranty shall also state that the replacement material shall conform to these specifications. The contractor shall submit a copy of the manufacturer's warranty to the Engineer along with the certificate of compliance required in subsection 705-1(A) of the specifications.

(B) Composition Requirements:

The preformed pavement marking material shall consist of the following components:

Minimum Percent by Weight	
Resins and Plasticizers	20
Reflective Glass Beads*	20*
Note: *Applicable only when glass beads are used to reflectorize Type I markings.	

(C) Physical Requirements:

(1) Color:

The pigments shall be selected and blended to provide a white or yellow marking layer which conforms to standard highway colors, when tested according to ASTM D6628, throughout the expected life of the layer.

(2) Bend Test:

The polymer layer shall be sufficiently flexible so that at a temperature of 78 to 82 degrees F an unmounted piece of material (without adhesive and paper backing), 3 inches by 6 inches in size, may be bent over a 1-inch mandrel until the end faces are parallel and 1 inch apart without showing any fracture lines in the uppermost surface.

(3) Tensile Strength:

The polymer layer (without adhesive or paper backing) shall have a minimum tensile strength of 40 pounds per square inch when a specimen 6 inches long by 1 inch wide is tested in accordance with the requirements of ASTM D638. The rate of pull of the test shall be 0.25 of an inch per minute. The test shall be conducted at a temperature between 70 and 80 degrees F. The elongation shall be no greater than 75 percent.

(4) Plastic Pull Test:

A 6-inch long by 1-inch wide section of the polymer layer (without adhesive and paper backing) shall support a dead load weight of 4 pounds for not less than five minutes at a temperature between 70 and 80 degrees F.

(5) Abrasion Resistance:

The polymer layer shall have a maximum loss in weight of 0.25 grams in 500 revolutions when abraded according to ASTM D4060.

(6) Skid Resistance:

The surface of the material shall provide a minimum resistance value of 45 British Pendulum Number (BPN) when tested according to ASTM E303.

705-2.02 Preformed Pavement Markings - Type II (Temporary - Removable):

Type II preformed pavement markings shall be a nonmetallic mixture of conformable materials and pigments intended for marking applications where removability is required. The marking material shall be white or yellow retroreflective layer conforming to standard highway colors.

The markings shall be precoated with a pressure sensitive adhesive capable of adhering to roadway surfaces under climatic and traffic conditions normally encountered in the construction work zone when applied in accordance with the manufacturer's instructions and without the use of heat, solvents or other additional adhesives. Newly applied markings shall be capable of being immediately exposed to traffic without pickup or distortion by vehicles. The markings shall be weather resistant and through normal traffic wear shall show no appreciable fading, lifting, shrinkage, tearing, loss of skid resistance, roll back or other signs of poor adhesion throughout the useful life of the marking.

Temporary pavement markings shall be removable from asphalt and concrete pavement intact or in large sections by following the manufacturer's instructions. It shall be removable, either manually or with a rollup device, at pavement temperatures above 40 degrees F

without the use of heat, solvents, grinding or sand blasting. Visible adhesive residue remaining after removal of temporary pavement markings shall be easily removable without damaging or scarring the pavement surface and without the use of solvents or grinding.

Pavement marking material without adhesive shall be a minimum of 0.045 inches thick. When supplied, the material shall be of good appearance, free from cracks, and edges shall be true, straight, and unbroken.

705-2.03 Preformed Pavement Markings - Type III (Temporary - Nonremovable):

Type III preformed pavement markings shall be a retroreflective layer on a conformable metallic backing intended for marking applications where removal is not a requirement. The marking material shall be white or yellow conforming to standard highway colors.

The markings shall be precoated with a pressure sensitive adhesive capable of adhering to roadway surfaces under climatic and traffic conditions normally encountered in the construction work zone when applied in accordance with the manufacturer's instructions and without the use of heat, solvents or other additional adhesives. Newly applied markings shall be capable of being immediately exposed to traffic without pickup or distortion by vehicles. The markings shall be weather resistant and through normal traffic wear shall show no appreciable fading, lifting, shrinkage, tearing, loss of skid resistance, roll back or other signs of poor adhesion throughout the useful life of the marking.

705-2.04 Preformed Thermoplastic Pavement Markings – Type IV (Permanent):

(A) General:

Preformed thermoplastic pavement markings shall be a resilient white, yellow, or other color thermoplastic material, composed of an ester-modified resin in conjunction with pigments, binders and glass beads that have been factory-produced as a finished product. The markings shall be resistant to the detrimental effects of motor fuels, lubricants, hydraulic fluids, and antifreeze. Preformed thermoplastic pavement markings shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting, or shrinkage or significant tearing, roll back, loss of skid resistance, or other signs of poor adhesion throughout the useful life of the marking.

The markings shall be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The marking shall have resealing characteristics, such that it is capable of fusing with itself or previously applied, worn thermoplastic pavement markings when heated with a common propane torch. The material shall not be brittle and shall be sufficiently cohesive

and flexible for one person to carry without danger of fracturing the material prior to application. Surface preparation primer shall also be applied if recommended by the manufacturer.

The material shall be supplied at a minimum thickness of 0.090 inches (90 mils). Symbols, legends, and short lines shall be capable of being affixed to bituminous and Portland Cement Concrete pavements by the use of the heat of a common propane torch. Any preheating requirements shall also be met by the use of the heat of a common propane torch and as recommended by the manufacturer.

Type IV preformed thermoplastic markings shall be suitable for use for one year after the date of manufacture when stored in accordance with the manufacturer's recommendation. Type IV marking materials supplied to the jobsite shall clearly display the date of manufacture, and shall be applied within one year of this date.

(B) Composition Requirements:

The preformed thermoplastic pavement marking material shall consist of the following components:

Component	Percent by Weight	
	White	Yellow
Binder (Min.)	18	18
Titanium dioxide (Min.)	10	-----
Yellow Lead-Free Pigment (Min.)	-----	1.5
Reflective glass inter-mix beads	30 – 45	30 – 45

(C) Physical Requirements:

(1) Color:

The pigments shall be selected and blended to provide a white or yellow preformed marking that conforms to standard highway colors, when tested according ASTM D6628, throughout the expected life of the preformed marking.

(2) Bend Test:

The preformed thermoplastic shall have flexibility at 50 degrees F such that when a specimen, measuring 6 inches long by 1 inch wide, is bent through an arc of 90 degrees at a uniform rate in 10 seconds (9 degrees per second) over a 1-inch mandrel, no cracking occurs in the test specimen. The specimen shall be conditioned prior to testing at 50 ± 2 degrees F for a minimum of four hours. At least two specimens tested shall meet the flexibility requirements at 50 degrees F for a passing result.

(3) Tensile Strength:

The preformed thermoplastic material shall have a minimum tensile strength of 150 pounds per square inch when tested in accordance with the requirements of ASTM D638. The rate of pull of the test shall be 10 to 12 inches per minute. The test shall be conducted at a temperature between 70 and 80 degrees F. The elongation shall be no greater than 20 percent.

(4) Bond Test:

The material shall exhibit a bond strength to Portland Cement Concrete pavement equal to or exceeding 180 pounds per square inch when tested at 73 ± 3 degrees F in accordance with the ASTM D4796.

(5) Abrasion Resistance:

The polymer layer shall have a maximum loss in weight of 0.25 grams in 500 revolutions when abraded according to ASTM D4060.

(6) Skid Resistance:

The surface of the material shall provide a minimum resistance value of 45 BPN when tested according to ASTM E303.

(7) Impact Resistance:

When tested in accordance with ASTM D256, Method A, a 1 inch by 1 inch by 6 inches sample shall not break when an impact energy of at least 1.0 joule is applied. The test specimen shall be prepared in accordance with ASTM D4960 and shall not be notched.

705-2.05 Retroreflectance:

All white and yellow pavement marking materials shall have the following minimum retroreflectance values when measured by the Department, using an LTL-X Delta Retrometer or similar device, within 30 days after application to the roadway surface:

Table 1	
Long Line Markings	**Retroreflectance (millicandelas/m²/lux)**
White	500
Yellow	300

Table 2	
Symbols, Legends, Short Lines	**Retroreflectance (millicandelas/m²/lux)**
White	350
Yellow	200

For sections determined to be deficient in retroreflectivity, the pavement markings shall be removed in a manner approved by the Engineer, and new markings shall be re-applied in accordance with the manufacturer's recommendations. For long lines, the limits of re-application shall start from the location of a passing test, across the failure area(s), to the next passing test location. The minimum length of reapplication shall be 0.4 miles. For symbols, legends, and short lines, the entire defective unit shall be re-applied.

705-2.06 Glass Bead Properties:

(A) General Requirements:

When glass beads are used to achieve retroreflectivity, the beads shall be manufactured from glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

(B) Physical Requirements:

(1) Roundness:

The roundness of the glass beads shall be determined in accordance with the requirements of ASTM D1155. A minimum of 75 percent of the beads shall be water-white true spheres free from imperfections of all types including air inclusions, film, scratches, clusters, and surface scoring.

(2) Refractive Index :

The glass beads used with the preformed pavement marking material shall have a minimum reflective index of 1.50 when tested by a liquid immersion method (Becke Line Method or equivalent, as specified in ASTM C1648) at a temperature at 25 ± 5 degrees C.

(3) Gradation:

The gradation of the glass beads shall conform to AASHTO M 247 Type 1 and Type 3.

(4) Heavy Metal Concentration:

Heavy metal concentration in glass beads shall be as specified in the following table, when tested by an independent laboratory, approved by the Engineer, using EPA Method 3052 and EPA Method 6010B. A Certificate of Analysis conforming to Subsection 106.05 of the specifications shall be furnished to the Engineer prior to use.

Heavy Metal	Concentration
Arsenic	< 75 ppm
Antimony	< 75 ppm

Lead	< 100 ppm

705-3 Construction Requirements:

The contractor shall install preformed pavement markings at the locations shown on the project plans, as specified in the Special Provisions, or as directed by the Engineer. Preformed marking tape shall be applied manually or with the tape applicators approved by the tape manufacturer. All markings shall be applied in accordance with the manufacturer's recommendations and as specified herein. Preformed pavement markings shall not be applied over other markings or old paint unless specified in the project plans, directed by the Engineer, or allowed by the manufacturer and approved by the Engineer prior to application.

Preformed pavement markings shall be applied to surfaces that are free of moisture and thoroughly cleaned of loose, foreign or other material that may adversely affect bonding. The contractor shall remove all dirt, dust, grease, oil or other detrimental material from the road surface. The method of cleaning the surface is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray.

When preformed markings are to be applied to new Portland Cement Concrete pavement, any curing compound present shall be removed by means of a high-pressure water jet or sandblasting, followed by sweeping and high-pressure air spray. The curing compound shall be removed at least 2 inches beyond the entire perimeter of each marking to be installed. In addition, a manufacturer approved primer-sealer shall be applied to both old and new Portland Cement Concrete pavement prior to application of preformed markings. The primer-sealer shall be applied at the manufacturer's recommended application rates prior to placing the preformed marking. The primer-sealer shall be allowed to set up for the manufacturer's specified cure or evaporation time, and shall be free of solvent and water when the preformed marking is applied.

Preformed pavement markings shall be applied immediately after the surface has been prepared or as soon as possible after placement and completion of new pavement. When Type I, II, or III markings are used, the road surface temperature, at the time of application, shall not be less than 60 degrees F and rising and the pavement surface shall be absolutely dry. For Type III temporary markings, the weather conditions noted above may be waived, at the Engineer's discretion, to obtain a traffic stripe prior to allowing traffic to traverse the roadway. Type II markings shall not be installed within 24 hours of any rainfall. In addition, if the possibility of rain is anticipated, as predicted by the National Weather Service, during the time required by the Engineer for installation of Type II markings, the contractor shall apply primer sealer prior to application of the marking, regardless of the type or age of pavement surface. Type IV markings shall be applied in accordance with the manufacturer’s recommendations for minimum temperature.

Despite the specified or recommended minimum surface temperature and surface condition, the Engineer may, at any time, require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the preformed pavement marking.

The contractor shall use butt splices only and shall not overlap the marking material. All markings shall be thoroughly tamped with approved mechanical tampers.

For preformed thermoplastic pavement markings requiring heat application on asphaltic concrete surfaces, the materials shall be applied using the propane torch method recommended by the manufacturer.

The contractor shall immediately correct all misalignments when so ordered by the Engineer. The misaligned portions shall be removed and reinstalled in accordance with these specifications. All areas marked with preformed pavement markings shall be ready for traffic immediately after application.

Type II or Type III temporary pavement markings shall be maintained and replaced when necessary by the contractor until they are covered with the next overlay course or are removed because they are no longer applicable. The temporary pavement markings shall be removed immediately when no longer needed for traffic control or when the temporary pavement markings will be in conflict with the succeeding traffic pattern. This removal includes the removal of pronounced markings caused by the adhesive across lanes, transitions or tapers. Removable temporary marking material shall not be burned or ground off. Preformed pavement markings shall be removed by methods recommended by the manufacturer and approved by the Engineer. Residual adhesive, ghosting, shadows or pavement scarring which might cause confusion during darkness or adverse weather conditions shall be removed immediately by the contractor when so ordered by the Engineer.

When Type I permanent pavement markings for final symbols, legends, and short lines are specified, Type I or Type IV pavement markings may be used, at the option of the contractor.

For the contrast pavement markings, the lead (white) reflective pavement markings shall be placed in 10-foot sections followed by 10-foot lag (non-reflective black) pavement markings. Lead-lag pavement markings shall be aligned longitudinally. Maximum gaps between the white and black reflective pavement markings shall not exceed 1 inch. All raised pavement markers should be placed midway between two white skip lines. Lead-lag pavement markings may be used only on the main line for lane line markings.

When the plans require Type I preformed long line or short line pavement markings to be placed in a groove, the contractor shall construct the

sawcut groove in accordance with the requirements of the special provisions.

The application of preformed pavement markings shall be in accordance with the recommendations of the manufacturer of the material and these specifications. After application, the pavement markings shall be immediately ready for exposure to traffic.

705-4 Method of Measurement:

Measurement of preformed pavement marking long lines and short lines will be made by the linear foot along the centerline of the pavement line and will be based on a 4-inch wide stripe. Measurement for pavement lines with a plan width greater or less than the basic 4 inches will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

If Oreo-type contrast pavement markings are used, the Plan Width of Striping (inches) will be the width of the reflective base pavement marking (white, yellow or other color) plus the 2 inch-wide borders on each side across the width of the reflective base pavement marking. Measurement for Oreo type pavement markings will be based on the combined width of the black and white markings.

Preformed pavement marking symbols, such as diamonds; single, double, or triple arrows; or freeway arrows, will be measured by each unit applied, regardless of configuration. Each pavement symbol, as shown on the plans, will be considered a unit.

Preformed pavement marking legends, defined as a complete letter grouping such as "SCHOOL," "XING," "STOP," “RR,” or "ONLY", will be measured by each unit applied. Each pavement legend, as shown on the plans, will be considered a unit.

Preformed pavement route-to-route freeway legends, defined as complete number and directional letter groupings, will be measured by each unit applied. Each complete route-to-route freeway legend, as shown on the plans, will be considered a unit.

Removal of curing compound from new Portland Cement Concrete pavement and the application of primer-sealer shall each be measured by the linear foot for striping lines regardless of width, or unit each for symbols and legends, and in accordance with the items of work established in the bid schedule.

705-5 Basis of Payment:

The accepted quantities of preformed pavement markings, measured as provided above, will be paid for at the contract unit price for the type

specified in the bidding schedule, which price shall be full compensation for the item, complete in place, including necessary pavement cleaning, primer, removal of Type II temporary markings, and maintaining Types II and III temporary markings in construction work zones.

No additional payment will be made for placement of Type I long line and short line pavement markings in sawcut grooves, the costs being considered as included in the contract price for the marking. Measurement and payment for sawcut grooves shall be in accordance with the special provisions.

Payment will be made for Type I and Type IV permanent pavement symbols, legends and short lines at the contract unit price, regardless of whether Type I or Type IV pavement markings are used.

The accepted quantities for removal of curing compound from new Portland cement concrete pavement and the application of primer-sealer, measured as provided above, will be paid for at the respective contract unit prices, under the items of work established in the bid schedule.

When Type II or III temporary preformed pavement markings are required for maintaining traffic through a construction work zone and are approved for use by the Engineer, but are not listed as pay items in the bidding schedule, they will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

Additional payment will be made for replacement of Type II or Type III temporary preformed pavement markings when the contractor is required by the Engineer to install marking materials on distressed pavements or during adverse weather conditions and subsequent failure occurs. Distressed pavement conditions are defined as alligator cracking, bleeding, or spalling of bituminous pavements and spalling of PCC pavements. Adverse weather conditions are defined as any occurrence where application is required at pavement temperatures less than 60 degrees F or when precipitation occurs within 24 hours before or after application. The Department will pay for the replacement, where failures occur, at the contract unit price for the initial occurrence.

In the event a second failure occurs when markings have been reapplied on distressed pavements or under weather conditions described above, the Engineer shall determine if conditions require primer, alternate methods of marking, or reapplication of preformed markings. Preformed markings will be paid for at the contract unit price. Primers or other methods of markings deemed necessary by the Engineer to remedy second failures will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

SECTION 706 RAISED PAVEMENT MARKERS:

706-1 Description:

The work under this section shall consist of cleaning and preparing the pavement surface; furnishing all materials, equipment, tools and labor; and placing raised pavement markers of the type specified at the locations and in accordance with the details shown on the plans and the requirements of these specifications.

706-2 Materials:

706-2.01 General:

Certificates of Compliance, for raised pavement markers and adhesive, conforming to the requirements of Subsection 106.05 of the specifications shall be submitted to the Engineer at least 10 days prior to use. A minimum of one sample per lot per type of marker shall be taken by the Engineer.

The pavement marker samples shall be tested to determine conformance to the applicable standard drawings and these specifications.

The base of the pavement markers shall be free from glass glaze or from substances which may reduce its bond to the adhesive. The base shall be flat and its deviation from a flat surface shall not exceed 0.05 inches.

706-2.02 Raised Retroreflective Pavement Markers:

The type of the raised retroreflective pavement markers shall be as shown on the plans.

Permanent raised retroreflective pavement markers shall conform to the performance requirements of ASTM D4280, Type A, B, or E, and shall meet the ASTM D4280 requirements for pavement markers with designation H for abrasion resistance and designation F for flexural strength. A list of approved permanent raised retroreflective pavement markers is shown on the Department's Approved Products List. Copies of the most recent version of the APL are available on the internet from the ADOT Research Center, through its Product Evaluation Program.

Temporary raised retroreflective pavement markers shall conform to the performance requirements of ASTM D4280, Type A, B, or E. Temporary raised retroreflective pavement markers, or permanent raised retroreflective pavement markers used as temporary, shall not be required to meet the ASTM D4280 designation H requirements for abrasion resistance.

706-2.03 Non-Reflective Pavement Markers and Retroreflectorized Channel Markers:

Non-reflective pavement markers shall be of the following types:

Type	Color
A	White
AY	Yellow
M	White
MY	Yellow

Retroreflectorized Channel Markers shall be of the following types:

Type	Color
J	White
JY	Yellow

Non-reflective pavement markers and retroreflectorized channel markers shall consist of a heat-fired, vitreous ceramic base and a heat-fired, opaque glazed surface which will produce the required properties. Markers shall be produced from any suitable combination of intimately mixed clays, shales, flints, feldspars, or other inorganic material which will meet the properties herein required. Markers shall be thoroughly and evenly matured and free from defects which will affect appearance or serviceability.

The top surface of the marker shall be in reasonably close conformity with the configuration shown on the plans. Markers shall be convex and the radius of curvature shall be between 3-1/2 and 6 inches, except that the radius of the 1/2 inch nearest the edge may be less. All edges shall be rounded and any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations.

Non-reflective pavement markers and retroreflectorized channel markers shall meet the following requirements:

Glaze Thickness: Inches	0.005 Minimum
Moh Hardness:	6 Minimum
Directional Reflectance: (White Only) Glazed Surface Body of Marker	 75 Minimum 70 Minimum
Yellowness Index: (White Only) Glazed Surface Body of Marker	 0.07 Maximum 0.12 Maximum
Color (Yellow Only): Purity: percent, range Dominant Wave Length: mu, range Total Luminous Reflectance (Y valve)	 75 - 96 579 - 585 0.41 Minimum
Compressive Strength: pounds	1,500 Minimum
Water Absorption: percent	2.0 Maximum
Autoclave	Glaze shall not spall, craze or peel

Retroreflectorized channel markers shall have encapsulated lens reflectors conforming to standard manufacturing practices.

706-2.04 Jiggle Bars:

(A) General:

Types K and KY jiggle bars shall be concrete or ceramic, at the option of the contractor, and shall be shaped to conform to the details shown on the plans. The same type of jiggle bar shall be used throughout any one project.

Jiggle bars shall be painted either white or yellow and shall be reflectorized, as shown on the plans. The color shall be uniform.

The bottom surface of the jiggle bars shall be of a roughness comparable to at least that of fine grade sandpaper. The bottom surface shall not be grooved such that air will be trapped in the grooves when it is pressed into the adhesive.

(B) Concrete:

Concrete jiggle bars shall be made of Class B concrete conforming to the requirements of Section 1006 of the specifications.

(C) Ceramic:

Ceramic jiggle bars shall be made of a heat-fired vitreous base. The glazed surface shall not craze, spall or peel when tested in accordance with the requirements of ASTM C424 for one cycle at 250 pounds per square inch.

The jiggle bar tiles shall have a compressive strength as follows when tested in accordance with the requirements of ASTM C773:

Minimum average of five units	6,000 psi
Individual minimum, one unit	5,000 psi

706-2.05 Bituminous Adhesive:

The bituminous adhesive for pavement markers shall be a hot-melt adhesive, and shall conform to the requirements of ASTM D4280, Annex A1. A list of approved adhesives is shown on the Department's Approved Products List (APL). Copies of the most current version of the APL are available on the internet from the ADOT Research Center, through its Product Evaluation Program.

706-3 Construction Requirements:

The portion of the highway to which the markers are to be attached shall be free of dirt, existing painted lines, curing compound, grease, oil, moisture, loose or unsound layers and any other material which could adversely affect the bond of the adhesive. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. On Portland cement concrete pavement and old asphaltic concrete pavements, cleaning shall be accomplished by sandblasting, followed by sweeping and/or air blowing. Newly placed asphaltic concrete pavement need not be sandblasted unless, in the opinion of the Engineer, the surface is contaminated with materials that would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface in an amount sufficient to result in complete coverage of the area of contact of the markers, with no voids present and with a slight excess after the markers have been placed. The markers shall be placed in position and pressure applied until firm contact is made with the pavement. The markers shall be protected against impact until the adhesive has set to the degree acceptable to the Engineer.

Excess adhesive on the pavement and on the exposed surfaces of the markers shall be immediately removed. Thinners or solvents which may be detrimental to either the markers or the bond provided by the adhesive shall not be used in removing excess adhesive.

Markers shall not be installed when the temperature of the pavement surface or the atmosphere is less than 40 degrees F, when the relative humidity is 80 percent or higher or when the pavement surface is not dry.

All markers shall be installed to the line approved by the Engineer and in such manner that the reflective face of the markers is perpendicular to a line parallel to the roadway centerline. No pavement markers shall be installed over longitudinal or transverse joints of the pavement surface.

706-4 Method of Measurement:

Raised pavement markers will be measured as a unit for each marker furnished and placed.

706-5 Basis of Payment:

The accepted quantities of raised pavement markers, measured as provided above, will be paid for at the contract unit price for the type designated in the bidding schedule, complete in place, including adhesive and surface preparation.

SECTION 707 TUBULAR MARKER (FLEXIBLE):

707-1 Description:

The work under this section shall consist of furnishing and installing flexible tubular markers in accordance with the details shown on the project plans and the requirements of these specifications. The work shall also include the removal and salvage of the markers when ordered by the Engineer.

707-2 Materials:

The post shall be of a flexible material which is resistant to impact, ultra violet light, ozone, hydrocarbons and stiffening with age. The base shall prevent post removal by impact or vandals. The post and base shall exhibit good workmanship and shall be free of burns, discoloration, contamination, and other objectionable marks or defects which affect appearance or serviceability.

The post shall be designed to resist overturning, twisting and displacement from wind and impact forces. A 50-mile per hour wind load shall not deflect the post more than 2 inches from the at-rest position. Measurement shall be made at the point of maximum deflection and normal to the movement.

The post shall have minimum tensile strength of 1,100 pounds per square. The tensile stress shall be determined in accordance with the "Standard Method of Test for Tensile Properties of Plastic," ASTM D638 (Test Specimen Type 1). The rate of jaw separation shall be 20 inches per minute.

The post shall be conditioned for a minimum of two hours in an oven at 140 ± 3 degrees F. The conditioned post shall be capable of straightening itself within 30 seconds when bent 180 degrees at the midpoint for each of four bends. The stress test on each post shall be completed within two minutes of removal from oven.

The post shall be sufficiently rigid to resist wilting after conditioning a minimum of two hours at 180 ± 3 degrees F.

The post shall be conditioned a minimum of two hours at -5 ± 3 degrees F in an environmentally controlled test chamber. Testing shall be performed in the environmental chamber. The post shall be sufficiently flexible to permit four 180-degree bends at the midpoint without cracking, each time straightening itself within 60 seconds.

The post shall be manufactured from an impact resistant material so that an installed post is capable of self-erecting and withstanding 10 vehicle impacts at 55 miles per hour at temperatures of 40 degrees F or above without breakage or loss of serviceability. Little or no damage shall be

caused to the impacting vehicle. The vehicle shall be a typical sedan with a weight of 4,000 ± 1,000 pounds.

The post shall also be capable of sustaining a wheel hit during testing at 55 miles per hour without loss of serviceability.

The reflective sheeting shall be a high reflectivity flexible sheeting conforming to the requirements of Section 1007 of the specifications. The sheeting must retain 75 percent of its reflectivity after 10 vehicle impacts at 55 miles per hour. Color shall be silver-white, yellow, or green in accordance with the appropriate Federal Highway Administration color tolerance chart.

The base shall prevent post removal by impact or vandals. The base shall not protrude more than 4 inches above the pavement surface.

707-3 Construction:

The base shall be installed with an epoxy adhesive or acceptable alternate, in accordance with the manufacturer's specifications.

When used in a construction work zone, it shall be the contractor's responsibility to keep the tubular markers bright and clean for maximum target value.

When replacement, repair or resetting of markers is necessary during traffic control in a construction work zone, such work shall be done immediately by the contractor.

707-4 Method of Measurement:

Tubular markers will be measured by the unit for each marker furnished and installed.

707-5 Basis of Payment:

The accepted quantities of tubular markers, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place, as specified herein and as shown on the plans.

It shall be the contractor's responsibility to reset those markers that become detached from the pavement at no additional cost to the Department.

Where the Engineer determines markers are in need of repair, such repairs shall be made by the contractor and will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

Where the Engineer determines markers need to be replaced, such replacement shall be made by the contractor and additional payment will be made at the contract unit price.

No measurement or direct payment will be made for removing, hauling and stockpiling salvaged markers, the cost being considered as included in the cost of the contract item.

SECTION 708 WATERBORNE PAVEMENT MARKINGS:

708-1 Description:

The work under this section shall consist of cleaning and preparing the pavement surface, furnishing all materials and applying white or yellow, water-borne, fast-dry or rapid-dry traffic paint, and reflective glass beads at the locations and in accordance with the details shown on the plans, MUTCD, and associated ADOT Supplement, the requirements of these specifications, or as directed by the Engineer.

708-2 Materials:

708-2.01 Pavement Marking Paint:

(A) General:

All material used in the formulation of the pavement marking paint shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

Only waterborne traffic paint that has been reviewed, evaluated, and approved by the ADOT Product Evaluation Program or equal, prior to the bid opening of each respective project, shall be used.

Copies of the most recent version of the Approved Products List (APL) are available on the internet from the ADOT Research Center through its Product Evaluation Program.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted along with precertification test results from the ADOT Central Laboratory for samples from each batch of material obtained for precertification at the production line of the manufacturer.

(1) Waterborne Pavement Marking Paint: Type I (Standard):

Type I (Standard) waterborne pavement marking paint shall be the traffic paint for long line and short line striping, arrows, symbols, and legends. Type I shall be used:

(a) For temporary traffic control;

(b) At the end of the construction work shift if the roadway is open to traffic over an intermediate layer of pavement while the final lift or layer of pavement has not been placed yet;

(c) As a primer on the final lift or layer of pavement 30 days prior to the application of the durable pavement marking materials; and

(d) During Construction on pavement that will not be resurfaced. Two applications of waterborne paint may be used, allowing 30 to 60 days between applications.

Type I paint shall be capable of performing as specified herein when subjected to high traffic volumes and severe wear conditions such as repeated crossing, starting, stopping, and turning movements.

(2) Waterborne Pavement Marking Paint: Type II (High-build):

Type II (High-build) waterborne pavement marking paint shall be used for long line and short line striping, arrows, symbols, and legends. Type II shall be used for temporary traffic control that needs to be in place for at least 180 days, and between two construction seasons.

Type II paint shall be capable of performing as specified herein when subjected to two-season projects, high traffic volumes, and severe wear conditions such as repeated crossing, starting, stopping, and turning movements.

(B) Composition Requirements:

The pavement marking paint shall be a ready-mixed, one component, waterborne traffic line paint of the correct color, to be applied to either asphaltic or Portland cement concrete pavement. The composition of the paint shall be determined by the manufacturer. It will be the manufacturer's responsibility to produce a pigmented waterborne paint containing all the necessary co-solvents, dispersant, wetting agents, preservatives and all other additives, so that the paint shall retain its viscosity, stability and all of the properties as specified herein.

Lead concentrations shall not exceed 0.009 percent by weight (90 ppm) using test method ASTM D3335.

The manufacturer shall certify that the product contains no detectable concentrations of:

Antimony;
Arsenic;
Cadmium;
Mercury;
Chromium, Inorganic;
Chromium, Hexavalent;
Toluene;
Chlorinated solvents;
Hydrolyzable chlorine derivatives;
Ethylene-based glycol ethers and their acetates; and/or
A carcinogen as defined in 29 CFR 1910.1200.

(C) Manufacturing Formulations:

The manufacturer shall formulate the pavement marking paint in a consistent manner and notify the Engineer of any change of formulation. The formulation of the paint shall be determined by the manufacturer. It will be the manufacturer's responsibility to formulate paint which will meet the quantitative and qualitative requirements of this specification. Any change in the formulation of the paint shall be approved by the Engineer.

(D) Quantitative Requirements of Mixed Paints:

Table 708-1

	White	**Yellow**
Pigment: Percent by weight, ASTM D3723, Allowable variation from the qualifying sample	± 2.0	± 2.0
Non-Volatile Content/Non-Volatile Vehicle: Percent by weight, ASTM D2369, Allowable variation from the qualifying sample	± 2.0	± 2.0
Viscosity: Krebs Units at 77 ± 1 °F, ASTM D562	70 - 95	70 - 95
Weight per Gallon: Pounds per gallon 77 ± 1 °F, ASTM D1475, Allowable variation from the qualifying sample	± 0.3	± 0.3
Vehicle Composition: Vehicle Infrared Spectra, ASTM D2621, Allowable variation from the qualifying sample	None	None
PH: ASTM E70, Allowable variation from the qualifying sample	± 1.0	± 1.0
Fineness of Dispersion: HEGMAN, minimum, ASTM D121	3.0	3.0
Volatile Organic Compounds: Pounds per gallon of paint, maximum, ASTM D3960 according to 7.1.2.	2.1	2.1

Table 708-1		
	White	**Yellow**
Flash Point: Degrees F., minimum, ASTM D93, Method A	100	100
Dry Time to No Pick Up: With no beads: minutes, maximum, ASTM D711	10	10
Dry Through Time: Minutes, ASTM D1640 except no thumb pressure is used when thumb is rotated 90° on paint film	20	20
Flexibility: ASTM D522, Method B: Flexibility shall be tested per ASTM D522, Method B. Draw down the paint to a wet film thickness of 0.005 inches (0.13mm) on a clean bare cold-rolled steel panel. Air-dry for 24 hours at standard conditions then bake for 5 hours at 221 °F ± 3 °F (105 °C ± 2 °C) and finally condition the panel for 30 minutes at standard conditions. When tested as specified the paint film shall not crack, chip, or flake after the test panel is bent over a ½ inch (13 mm) diameter, cylindrical mandrel.	Pass	Pass

(E) Qualitative Requirements:

(1) Color of Yellow Paint:

The color of the yellow paint shall closely match Federal Standard 595b, Color No. 33538.

(2) Dry Opacity:

Dry opacity for the paint will be determined using a black-white Leneta Chart, Form 2C Opacity, or equal, and a calibrated reflectance meter capable of determining reflectance to the nearest 1 percent. Using a 10 mil gap doctor blade, a film of paint is drawn down, covering both black and white portions of the chart on a vacuum plate. The film shall be allowed to dry 24 hours. After calibrating the meter according to the manufacturer's instructions, measure the reflectance over the white and black portions according to the manufacturer's instructions. Dry Opacity for both white and yellow paint shall be at least 0.90.

(3) Yellowness Index:

Yellowness Index for white paint will be determined as described for dry opacity, only use a 15-mil gap doctor blade to draw down the paint. Calculate the Yellowness Index in accordance with ASTM E313. Yellowness Index for the white paint shall be a maximum of 10.

(4) Reflectance:

Reflectance for both white and yellow paint will be determined using the same 15-mil draw-down film as for the Yellowness Index. For white paint the same sample may be utilized for both the Yellowness Index and Reflectance. Measure the reflectance of the paint film using the reflectance meter according to the manufacturer's instructions. Reflectance for the white paint shall be at least 85. Reflectance for the yellow paint may range from 42 to 59, inclusive.

(5) UV Color Durability:

UV Color Durability shall be determined using a QUV Weatherometer, with Ultra Violet Light and Condensate Exposure according to ASTM G154, for 300 hours total. The repeating cycle shall be four hours UV exposure at 140 degrees F (60 degrees C) followed by four hours condensate exposure at 104 degrees F (40 degrees C). After 300 hours of exposure, the Yellowness Index for white paint shall not exceed 12, and yellow paint shall closely match Federal Standard 595b, Color No. 33538.

(6) Static Heat Stability:

To determine static heat stability for the paint, place 1 pint of paint in a sealed can and heat in an air circulation oven at 120 ± 1 degrees F (49 degrees C) for a period of one week. Remove the paint from the oven and check the viscosity in Krebs Units at 77 ± 1 degrees F (25 degrees C) according to ASTM D562. The viscosity measured shall be in the range from 68 to 90 Krebs Units, inclusive. Also, check for any signs of instability.

(7) Heat-Shear Stability:

To determine heat-shear stability for the paint, 1 pint of the paint is sheared in a Waring Blender at high speed to 150 degrees F (66 degrees C). The blender should have a tight fitting lid taped onto it to minimize volatile loss. When the paint reaches 150 degrees F (66 degrees C), stop the blender, immediately pour the paint into a sample can, and apply a cover to seal the can. Let the paint cool overnight and examine for jelling or other signs of instability. Measure viscosity in Krebs Units at 77 ± 1 degrees F (25 degrees C), according to ASTM D562. The viscosity measured shall be in the range from 68 to 95 Krebs Units, inclusive. If not within the upper limit, run total solids on the sheared paint and adjust solids, if necessary, by adding water to reach the original solids content. If the solids content required adjustment, again check the viscosity of the paint. The viscosity shall be in the range from 68 to 95 Krebs Units, inclusive.

(8) Scrub Resistance:

Scrub Resistance will be determined according to ASTM D2486. Use an appropriate doctor blade to provide a dry film thickness of 3 to 4 mils. Allow the paint to cure for 24 hours. Perform the scrub resistance test at 77 ± 1 degrees F (25 degrees C) and 50 ± 5 percent humidity. Record the number of cycles to remove the paint film. The number of cycles recorded shall be at least 800.

(9) Spraying Properties:

The paint shall be applied, in the field, at a 15 mils wet film thickness for Type I paint and 25 mils wet film thickness for Type II. Both Type I and Type II paint shall show the following properties at ambient temperatures of 50 to 100 degrees F (10 to 38 degrees C) with paint spray temperature of 150 degrees F (66 degrees C), maximum.

For Type I paint, 6 to 10 pounds of Type 1 beads shall be post-applied per gallon of paint. For Type II paint, 10 to 12 pounds of Type 3 beads shall be post-applied per gallon of paint. Beads shall conform to subsection 708-2.02 of the specifications.

(a) For rapid-dry paint applied in a mobile operation and not protected by temporary traffic control, dry to a no-track condition in 60 seconds or less when the line is crossed over in a passing maneuver with a standard-sized automobile.

(b) For fast-dry paint applied within an established work zone behind temporary traffic control, dry to a no-track condition in five minutes or less when the line is crossed over in a passing maneuver with a standard-sized automobile.

(c) Produce a clean-cut, smooth line with no overspray or puddling.

(d) Paint immediately after application shall accept glass beads so that the spheres shall be embedded into the paint film to a depth of 50 percent of their diameter.

(e) Paint when heated to the temperature necessary to obtain the specified dry time, shall show no evidence of instability such as viscosity increase, jelling, or poor spray application.

(10) Freeze-Thaw Properties:

The paint viscosity or consistency shall not change significantly when the paint is tested for resistance to five cycles of freeze-thaw according to ASTM D2243.

(11) Road Service Rating:

Test stripes of the paint shall be applied transversely across the road, 4 inches in width and approximately 12 feet long at a location approved by the Engineer.

Wet film thickness of the test stripes shall be approximately 15 mils for Type I and 25 mils for Type II paint as determined according to ASTM D4414 and ASTM D713 prior to test stripe application. To aid in obtaining the correct film thickness, a length of roofing paper placed by the side of the road can be used. Place a rigid metal test panel on the roofing paper in the path of a test line. Immediately after the test line is applied by the striper, measure the wet film thickness. If not satisfactory, adjust the spray pressure and repeat until the target wet film thickness is attained. It is important that no glass beads be present that would give a false wet film thickness. When the wet film thickness is correct, apply a test line across a tared metal test panel. After this, apply another test line across a different tared metal test panel, this time also adding the beads. These samples are necessary to determine the initial bead retention.

Glass beads conforming to the requirements of Subsection 708-2.02 of the specifications (moisture proof type) shall be applied after the paint has been applied, but during the same striping operation at a rate such that the initial bead retention on the test line is at least 6 pounds of beads per gallon of wet paint for Type I paint and at least 10 pounds of beads per gallon of wet paint Type II. The initial bead retention will be determined analytically by the ADOT Construction and Materials Group concurrently with the determination of the dry paint thickness utilizing tared metal test panels. The paint shall accept the glass beads so that the spheres are embedded into the paint film to a depth of 50 percent of their diameter. Test stripes will be observed for a period of 180 days from date of application. Paints will be evaluated for wear according to ASTM D913.

After 180 days of service, on a visual rating scale of 0 to 100 percent, paints shall have a rating of 90 percent or better to be acceptable. All ratings will be taken in the wheel track area. Glass beads shall show no more than a 30 percent loss after 180 days of test. This will be determined by taking close-up, before and after photographs of the paint film and by count determining the average bead loss.

The road service test may be waived at the option of the Engineer or evaluated for a period of time less than 180 days.

(12) Workmanship:

Paint shall be free from foreign materials, such as dirt, sand, fibers from bags, or other material capable of clogging screens, valves, pumps, and other equipment used in a paint striping apparatus.

The paint pigment shall be well ground and properly dispersed in the vehicle. The pigment shall not cake or thicken in the container, and shall not become granular or curdled. Any settlement of pigment in the

paint shall result in a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sidewise manual motion of a paddle across the bottom of the container, to form a smooth uniform product of the proper consistency. If the paint cannot be easily redispersed, due to excessive pigment settlement as described above or due to any other cause, the paint shall be considered unfit for use.

The paint shall retain all specified properties under normal storage conditions for 12 months after acceptance and delivery. The contractor shall be responsible for all costs and transportation charges incurred in replacing paint that is unfit for use. The properties of any replacement paint, as specified herein, shall remain satisfactory for eight months from the date of acceptance and delivery.

(F) Manufacturing Requirements:

(1) Inspection:

The manufacturer of the paint shall furnish the Engineer free access to all parts of the plant involved in the paint manufacture, and shall furnish every reasonable facility for sampling both the paint and the raw materials during the process of manufacturing.

All materials used in formulation shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

All manufactured paint shall be prepared at the factory ready for application.

When paint is shipped to a distributor or paint applicator who will store the paint prior to its use, the distributor or paint applicator shall furnish the Engineer free access to all parts of the facility where paint is stored and shall furnish every reasonable facility for sampling the paint.

Paint may also be sampled at the place of storage either at a warehouse or on the site prior to application of the paint. Application of the paint will not be permitted until the paint has been approved by the Engineer. It is the contractor's responsibility to notify the Engineer at least 14 working days prior to any traffic painting operation and to allow access at that time for paint sampling at the storage location.

At least one paint sample shall be obtained from each lot of paint.

Check-samples of finished paint while being applied will be taken at intervals as determined by the Engineer.

(2) Precertification of Pavement Marking Paint :

All tests will be conducted as specified herein.

(a) General:

As described in Subsection 708-2.01(A) of the specifications, the contractor shall provide to the Engineer a Certificate of Compliance from the manufacturer and test results from the Central Laboratory for samples from each batch of material obtained for precertification at the production line of the manufacturer. If the material fails the precertification testing by Central Laboratory, the manufacturer shall not supply any pavement marking paint represented by the failing test results to ADOT projects. If the material fails the precertification testing by the Central Laboratory, the manufacturer shall not supply any pavement marking paint represented by the failing test results to ADOT projects.

(b) Precertification Sampling:

Sampling of pavement marking paint for precertification shall be for an active ADOT project. The manufacturer shall provide a 1 pint or 1 quart sample in a metal can of pavement marking paint from each batch of production that will be shipped to an ADOT project. The manufacturer shall ship the composite sample to the Central Laboratory at 1221 N. 21st Avenue Phoenix, AZ 85009, along with a Certificate of Analysis, for precertification testing. The manufacturer shall identify the pavement marking paint with the batch number, the batch quantity, the batch date, the manufacturer's name, and the product name. Such identification shall be shown on the side of the container.

(c) Central Laboratory Precertification Testing Responsibilities:

The Central Laboratory is responsible for coordinating precertification for each batch of pavement marking paint that is to be precertified.

For precertification purposes, pavement marking paint at a minimum will be tested for color, total non-volatile percentage, pigment, non-volatile vehicle, weight per gallon, viscosity, dry time, and dry opacity in accordance with the procedures described in Subsection 708-2.01(D) and 708-2.01(E) of the specifications.

Upon completion of testing, the Central Laboratory will provide the manufacturer with a copy of the test results for each batch tested. Typically, testing will be completed within five working days of receipt of the paint sample. If the material fails the precertification testing, the manufacturer shall not supply any pavement marking paint represented by the failing test results to ADOT projects.

Evidence of adulteration or improper formulation shall be cause for rejection.

(d) Packaging:

All shipping containers for paint shall comply with the Department of Transportation Code of Federal Regulations, Hazardous Materials and Regulation Board, Reference 49 CFR. The container and lids shall be lined with a suitable coating so as to prevent attack by the paint or by agents in the air space above the paint. The lining shall not come off the container or lid as skins.

Containers shall be colored white, including lids, and containers shall have an identifying band of the appropriate color around and within the top one third of the container.

All containers shall be properly sealed with suitable gaskets, shall show no evidence of leakage, and shall remain in satisfactory condition for a period of 12 months after delivery to a distributor or paint applicator. The contractor shall be responsible for all costs and transportation charges incurred in replacing paint and containers.

(e) Labeling:

All containers of paint shall be labeled showing the manufacturer's name, date of manufacture, paint color, product code, manufacturer's batch number, and quantity or weight of paint on both the side of the container and also the lid. Containers shall be clearly labeled Rapid Dry or Fast Dry lead-free Waterborne Type I or Type II Traffic Paints.

All containers of paint shall be labeled to indicate that the contents fully comply with all rules and regulations concerning air pollution control in the State of Arizona, Maricopa County.

The manufacturer of the paint shall be responsible for proper shipping labels with reference to whether the contents are toxic, corrosive, flammable, etc., as outlined in the U.S. Department of Transportation, Hazardous Materials Regulations, Reference 49 CFR.

(f) Unused Paint:

Disposal of unused quantities of traffic paint shall be the responsibility of the contractor and shall meet all applicable Federal regulations for waste disposal. Paint which is saved to be used later shall be packaged as specified and shipped to a storage location. Unused paint shall be identified on the container. Unused paint may be utilized on a future project provided the paint still conforms to all specifications contained herein.

708-2.02 Reflective Glass Beads (Spheres):

(A) General:

The term "glass bead" shall be synonymous with the term "glass sphere" as used herein.

The beads shall be manufactured from glass of a composition designated to be highly resistant to traffic wear and to the effects of weathering.

The glass beads shall be moisture-proof; contain less than 0.25 percent moisture by weight; and be free of trash, dirt, or other deleterious materials.

Beads shall be essentially free of sharp angular particles showing milkiness or surface scoring or scratching. Beads shall be water white in color.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

(B) Physical Requirements:

(1) Gradation:

The gradation for the drop-on beads shall conform to AASHTO M 247 Type 1 and Type 3.

(2) Roundness:

Glass beads shall conform to AASHTO M 247, Type 1 and Type 3. Beads retained on any screen specified in the gradation requirements shall contain at least 80 percent true spheres.

(3) Index of Refraction:

Glass beads shall conform to AASHTO M 247, Type 1 and Type 3.

(4) Specific Gravity:

The specific gravity of the beads shall be in the range 2.40 to 2.60 when tested in accordance with the following procedures:

Place 100 grams in an oven at 230 degrees F (110 degrees C) for one hour.

Remove beads and place in a desiccator until the sample is cool.

Remove approximately 60 grams of beads from the desiccator and weigh the sample accurately.

Pour the beads slowly into a clean 100-milliliter graduated cylinder containing 50 milliliters of isopropyl alcohol. Make certain that air is not entrapped among the beads.

The total volume reading on the graduated cylinder, minus 50, will give the volume of the beads. Calculate the specific gravity as follows:

$$\text{Specific Gravity} = \frac{\text{Weight of the sample}}{\text{Volume of the sample}}$$

(5) Chemical Stability:

Beads which show any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture, dilute acids, or alkalis or paint film constituents, may be required to demonstrate satisfactory reflectance behavior, prior to acceptance, under such tests as may be prescribed.

(6) Hazardous Constituents:

Each lot shall be tested for heavy metal concentration as specified in the following table, tested by an independent laboratory approved by the Engineer, using EPA Method 3052 and EPA Method 6010B.

Table 708-2

Heavy Metal	Concentration
Arsenic	< 75 ppm
Antimony	< 75 ppm
Lead	< 0.009% by weight (90 ppm)

The manufacturer shall certify that the product contains no detectable concentrations of other hazardous constituents, including:

Cadmium;
Barium;
Mercury;
Chromium, Inorganic;
Chromium, Hexavalent; and/or
A carcinogen as defined in 29 CFR 1910.1200.

(C) Bead Coating:

All glass beads shall have a moisture-proof adhesion enhancing overlay, consisting of a properly formulated material which prevents bead clumping and clogging and promotes proper embedment and adhesion to the applied paint. Water repellent material applied during the process of bead manufacture. The beads so treated shall not absorb moisture in storage and shall remain free of clusters and lumps and shall flow freely from dispensing and testing equipment.

The beads shall conform to AASHTO T 346.

(D) Acceptance of Glass Beads:

(1) Preapproval Sampling of Glass Beads:

Sampling of glass beads shall be for an active ADOT project. For preapproval of glass beads, the Structural Materials Testing Section will obtain a sample from each lot at the striping contractor's yard as requested by the striping contractor. At least a 1 gallon sample taken from a "super sack" shall be sampled for each lot. When sampling a lot consisting of multiple super sacks, no less than four super sacks shall be sampled, and the samples combined to make one sample. A field sample shall consist of at least a 1 gallon sample taken from the striping truck for each lot. Each field sample shall be identified with the manufacturer's lot number. When sampling from the striping truck, the sample shall be obtained from the drop nozzle after 500 feet of striping has been placed. Unless the inspector suspects contamination of the glass beads, no field samples will be required for preapproved lots.

(2) Preapproval Testing of Glass Beads:

Glass beads will be tested in accordance with Subsection 708-2.02(B) and 708-2.02(C) of the specifications for gradation, roundness, refraction, and moisture resistance coating. For each lot of glass beads that is to be preapproved, the Structural Materials Testing Section will perform the sampling and testing. A test report with the lot number will be issued for each project the glass beads are to be used for. Upon completion of testing for preapproval, the Structural Materials Testing Section will provide the striping contractor with a copy of the test results.

For glass beads that have not been preapproved, the Structural Materials Testing Section will test field samples submitted by the project. The issuance of a test report and the maintaining of a log of all lots tested will be completed as described for glass beads tested for preapproval. The Structural Materials Testing Section will immediately notify the project of any failing test results.

708-3 Construction Requirements:

708-3.01 Equipment:

The traffic paint and beads shall be placed on the pavement by a spray-type, self-propelled pavement marking machine except that temporary striping during construction may be placed with other equipment designed for application of paint and beads.

The application equipment to be used on roadway installation shall have, as a minimum, the following characteristic and/or apparatus:

(A) Capable of applying clear-cut lines of the width specified on the project plans;

(B) Equipped with a mechanical device capable of placing a broken reflectorized line with a 10-foot painted segment and a 30-foot gap; and

(C) Equipped with an air-operated glass bead drop-in dispenser controlled by the spray gun mechanism.

A glass bead dispenser which is capable of placing the glass beads into the paint line as the paint is applied to the pavement shall be utilized. This dispenser shall provide satisfactory marking and delineation.

708-3.02 Application:

Pavement markings shall be applied when the pavement surface is dry and the weather is not foggy, rainy, or otherwise adverse to the application of markings. The surface shall be free from excess asphalt or other deleterious substances before traffic paint, beads or primer are applied. The contractor shall remove dirt, debris, grease, oil, rocks or chips from the pavement surface before applying markings. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. The placing of traffic markings shall be done only by personnel who are experienced in this work.

Painting shall not be performed when the atmospheric temperature is below 50 degrees F (10 degrees C) when using waterborne paint, nor when it can be anticipated that the atmospheric temperature will drop below 50 degrees F (10 degrees C) temperature during the drying period. Waterborne paints shall not be applied if rain is expected within one hour of its application, unless otherwise approved by the Engineer. Waterborne paint shall not be heated to a temperature greater than 150 degrees F (66 degrees C) to accelerate drying.

The volume of paint in place shall be determined by measuring the paint tank with a calibrated rod. At the discretion of the Engineer, if the striping machine is equipped with air-atomized spray units (not airless) and paint gauges, the volume of paint may be determined by utilizing said gauges.

The quantity of glass reflectorizing beads in place shall be determined by measuring the glass reflectorizing bead tank with a calibrated rod.

The contractor shall provide the necessary personnel and equipment to divert traffic from the installation area where the work is in progress and during drying time when, in the opinion of the Engineer, such diversion of traffic is necessary.

Painted markings placed below the final surface shall be placed immediately after a change in long-term traffic patterns/configurations, when the need arises, or as directed by the Engineer. On intermediate lifts of overlay projects, painted markings shall consist of at least 4-inch wide by 4-foot long strips of reflective material, placed at 40 foot intervals. In situations involving severe degree of curvature, the Engineer may direct that the length and spacing be adjusted to 2 feet and 20 feet, respectively. These requirements apply to white lane lines separating traffic moving in the same direction and to yellow center lines for two-lane, two-way roadways in areas where passing is permitted. Painted markings shall be placed on each subsequent pavement course.

Curing compound shall be removed from new concrete surfaces before the placement of painted markings.

Tolerances for Placing Paint, Beads, and Primer:

(A) The length of painted segment and gap shall not vary more than 6 inches in a 40-foot cycle;

(B) The finished line shall be smooth, aesthetically acceptable and free from undue waviness;

(C) Painted lines shall be 4, 8, or 12 inches wide as shown on the plans with a tolerance of ± 1/8 inch and shall be placed at a minimum rate of 16 gallons per mile for a solid 4-inch line and 4 gallons per mile for a broken 4-inch line, based on a 10-foot stripe and a 30-foot gap (40-foot cycle aggregate);

(D) Glass reflectorizing beads shall be applied on the wet paint. For Type I paint, 6 to 10 pounds of Type 1 beads shall be post-applied per gallon of paint. And, For Type II paint, 10 to 12 pounds of Type 3 beads shall be post-applied per gallon of paint; and

(E) Wet thickness shall not be less than 15 mils wet film thickness for Type I paint and 25 mils wet film thickness for Type II, unless otherwise shown on the plans.

708-4 Method of Measurement:

Pavement marking paint will be measured by the linear foot along the centerline of the pavement stripe. Skips in dashed lines will not be included in the measurement. Length of pavement markings will be based on a 4-inch wide stripe. Measurement for striping with a plan width greater or less than the basic 4 inches as shown on the plans or directed by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

Symbols and legends will be measured by each unit applied. Each legend, regardless of the number of letters, will be considered as a single unit.

708-5 Basis of Payment:

Pavement striping of the type specified, measured as provided above, will be paid for at the contract price per linear foot for the total length of painted line applied to the nearest foot, which price shall be full compensation for the work, complete in place, including glass beads, as described and specified herein and on the project plans.

Pavement symbols and legends measured as provided above, will be paid for at the contract price for each painted symbol or legend, which price shall be full compensation for the work, complete in place, including glass beads, as described and specified herein and on the project plans.

SECTION 709 DUAL COMPONENT PAVEMENT MARKINGS:

709-1 Description:

The work under this section shall consist of cleaning and preparing pavement surfaces and furnishing and applying either white or yellow reflectorized dual component pavement markings to the prepared pavement at the locations and in accordance with the manufacturer's specifications, the details shown on the project plans and the requirements of these specifications. The type of dual component marking system, marking configuration and thickness shall be in accordance with the project plans and these specifications.

709-2 Materials:

709-2.01 General Requirements:

The dual component pavement marking material shall be a liquid or 100 percent solids epoxy or other dual component UV-stabilized system, formulated and designed to provide a simple volumetric mixing ratio of the two components (resin and catalyst). The characteristics of the material shall be such that complete and even coverage of specified areas to the required thickness is provided by the required application method and rate. Upon drying the dual component material shall produce an adherent durable reflectorized marking capable of resisting deformation and wear in the roadway. The material shall be suitable for application to old and new asphaltic concrete and Portland cement concrete pavement surfaces.

A list of approved manufacturers of dual component pavement marking material is shown on the Department's Approved Products List (APL). The most current version is available on the internet from the Arizona

Transportation Research Center (ATRC), through its Product Evaluation Program.

709-2.02 Epoxy Composition Requirements:

Epoxy pavement marking material shall conform to the following requirements:

(A) Composition:

The epoxy resin material shall be within the following compositional requirements:

Component	Percent by Weight	
	White	Yellow
White Pigment (Titanium Dioxide)	18 - 25	10 -17
Organic Yellow Pigment	---	7 - 10
Epoxy Resin	75 - 82	73 - 83

The white pigmented pavement marking material shall be tested in accordance with ASTM D3723 and shall conform to the requirements specified in ASTM D476 (Type II).

(B) Epoxide Number:

The epoxide number of the epoxy shall be determined in accordance with ASTM D1652 for both white and yellow resin material on a pigment free basis. The epoxide number shall be within ± 50 of the published manufacturer's standard for the approved product.

(C) Amine Number:

The amine number of the curing agent shall be determined in accordance with ASTM D2074. The amine number shall be within ± 50 of the published manufacturer's standard for the approved product.

(D) Toxicity:

Upon heating to application temperature, the material shall not exude fumes which are toxic or injurious to persons or property.

(E) Adhesion to Concrete:

The epoxy marking materials, when tested according to ACI Method 503, shall have a higher degree of adhesion to the specified concrete (4,000 pounds per square inch, minimum) surface, such that there shall be a 100 percent concrete failure in the performance of this test. The samples shall be allowed to cure at room temperature (75 ± 2 degrees F,) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated tests.

(F) Hardness:

The epoxy paint pavement markings material, when tested according to ASTM D2240, shall have a Shore D Hardness of between 70 to 95. The samples shall be allowed to cure at room temperature (75 ± 2 degrees F) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated tests.

(G) Abrasion Resistance:

The abrasion resistance shall be evaluated on a Taber Abrader with a 1,000 gram load and CS-17 wheels. The duration of the test shall be 1,000 cycles. The wear index shall be calculated based on ASTM C501, and the wear index for the dual component material shall not be more than 90 milligrams. The test shall be performed on cured samples of material which have been applied, without glass beads, at a film thickness of 0.020 ± 0.0005 inches to code S-16 stainless steel plates. The samples shall be allowed to cure at room temperature (75 ± 2 degrees F) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated tests.

(H) Tensile Strength:

When tested in accordance with ASTM D638, the epoxy marking materials shall have an average tensile strength of not less than 6,000 pounds per square inch. The Type IV specimens shall be cast in a suitable mold and pulled at a rate of 1/4 inch per minute by a suitable dynamic testing machine. The samples shall be allowed to cure at room temperature (75 ± 2 degrees F) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated tests.

(I) Compressive Strength:

When tested according to ASTM D695, the epoxy pavement marking materials shall have an average compressive strength of not less than 11,000 pounds per square inch. The samples shall be allowed to cure at room temperature (75 ± 2 degrees F) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated tests.

(J) Retroreflectance:

All white and yellow pavement marking materials shall have the following minimum retroreflectance values when measured by the Department, in accordance with ASTM E1710 within 30 days of application, but no sooner than three days after application to the roadway surface. Retroreflectance readings should be performed in accordance with Subsection 709-3.03(B) of the specifications.

Product	Retroreflectance (Millicandelas)
White	200

Yellow	150

Additionally, all white and yellow markings placed in the field shall also exhibit the same minimum retroreflectance values 30 days after application to the roadway surface. Markings not complying shall be removed and replaced at no additional cost to the Department.

(K) Color:

The colors of the applied markings shall comply with the requirements specified in ASTM D6628 and shall conform to the following:

(1) The white color shall match Federal Test Standard Number 595B, color chip no. 37875; and

(2) The yellow color shall match Federal Test Standard Number 595B, color chip no. 33583.

(L) Yellowness Index:

The initial yellowness index value of the white material shall be tested in accordance with ASTM E313. The sample shall be cured for 72 hours at room temperature (75 ± 2 degrees F) prior to testing. The initial yellowness index shall not exceed a value of 8.

The yellowness index value of the white material shall be tested in accordance with ASTM E313 and ASTM G154. The sample shall be cured for 72 hours at room temperature (75 ± 2 degrees F) and then exposed in the QUV chamber for 72 hours and 500 hours respectively. The yellowness index values shall not exceed the values shown in the table below.

Exposure Time (hours)	Yellowness Index
72	15
500	27

(M) Viscosity:

The formulations of each component part shall be such that the viscosity of both parts, when measured in accordance with ASTM D2196, Method A, shall be within 10 percent of each other at the recommended spray temperature.

(N) Curing and No-Track Time:

No-track time shall be defined as the time necessary for the epoxy marking to cure to a no-track condition. The epoxy marking, when properly applied with the required gradations and bead application rates per gallon, shall cure to a no-track condition, when tested in accordance

with ASTM D711, within 30 minutes at 40 degrees F, and no more than 20 minutes at temperatures of 70 degrees F or more.

The applied epoxy material shall be capable of fully curing at a minimum pavement surface temperature of 32 degrees F. At room temperature (75 ± 2 degrees F), a sample shall be capable of curing to full strength in 72 hours.

(O) Storage Life:

The materials shall meet the requirements of this specification for a period of at least one year from the date of manufacture. The month and year of manufacture shall be clearly marked on all containers. Product MSDS information shall be attached to material containers at all times. Any material which does not meet the above requirements, or which is no longer within this one-year period at the time of application, shall not be used unless approved by the Engineer. The contractor shall replace any outdated material with material meeting the above performance and time requirements at no additional cost to the Department.

(P) Testing and Certificates:

When requested by the Engineer, the contractor shall provide liquid samples of the catalyst and resins in appropriate containers for testing. Certificates of Analysis conforming to Subsection 106.05 of the specifications shall be submitted for all materials, and shall include the Material Safety Data Sheets (MSDS).

709-2.03 Glass Beads:

The glass beads shall be colorless, transparent, free from milkiness or excessive air bubbles, and essentially clean from surface scarring or scratching. They shall be spherical in shape, and at least 70 percent are to be true spheres when tested in accordance with ASTM D1155, Procedure A. The refractive index of the spheres shall be a minimum of 1.5 as determined by the liquid immersion method A 25 DC. The silica content of the glass beads shall not be less than 60 percent. The beads shall have the following gradation when tested in accordance with ASTM D1214:

TYPE A GLASS BEADS (Large Bead)	
Sieve No.	**% Retained**
10	0
12	0 - 5
14	5 - 25
16	40 - 80
18	10 - 40
20	0 - 5
Pan	0 - 2

TYPE B GLASS BEADS (Small Bead)	
Sieve No.	**% Retained**
20	0 - 5
30	5 - 25
50	30 - 75
80	9 - 32
100	0 - 5
Pan	0 - 2

The Type A and B glass beads shall have a moisture-proof coating, and shall be dual-coated with a silane-type adherence coating. The glass beads shall display no tendency to absorb moisture in storage, and shall remain free of clusters and lumps. The beads shall flow freely from dispensing equipment at the time of application. The moisture-resistance of the glass beads shall be determined in accordance with Subsection 708-2.02(C) of the specifications. Heavy metal concentration in glass beads shall conform to the requirements of Subsection 708-2.02(B)(6) of the specifications.

Certificates of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for the glass beads to be used on the dual component pavement marking systems. The certificate shall also include a Material Safety Data Sheet (MSDS).

709-3 Construction Requirements:

709-3.01 Equipment:

The pavement marking equipment for longitudinal lines shall have a system capable of spraying both yellow and white dual component pavement markings. The marking vehicle shall be of sufficient size and stability with an adequate power supply to produce lines of uniform dimension, with square edges, and proper mix of the two component parts to ensure proper application. The equipment shall be capable of placing markings and applying glass beads at both the left and right sides of the truck, and placing two lines simultaneously with either line in a solid or intermittent pattern in either yellow or white. All sprayers shall be in full view of the operators at all times. The equipment shall be provided with a metering device to register the accumulated installed pavement marking for each sprayer, each day. The contractor shall provide a certificate from the American Traffic Safety Services Association (A.T.S.S.A.), or equivalent documentation, to the Engineer to verify that the driver and operator of the application truck are fully trained and experienced in the application of the dual component marking system being applied. The equipment shall include pressure gauges for each proportioning pump which are visible to the operator at all times, so that any fluctuations can be detected immediately during the marking operations.

The longitudinal line application vehicle shall be equipped with high pressure air spray jets in front of the striping material and glass bead

applicators to remove loose matter on the pavement surface where the marking material is to be applied.

The vehicle shall be equipped with two separate glass bead supply tanks and two glass bead dispensers per each marking material sprayer. The contractor shall provide documentation to the Engineer that bead dispensers are specifically manufactured for the glass bead application rates contained herein. When Type A gradations of glass beads are applied, the vehicle shall be equipped with high-capacity cone-shaped pressure or gravity dispensers. All bead dispenser outlets shall have enclosed wind shrouds or equivalent devices to direct the glass beads as they are applied. The shroud may include an opening which faces the operator so that the flow rate of the glass beads can be monitored. The bottom of the shroud shall be mounted within 3 to 4 inches of the pavement surface and be configured to allow for even distribution of glass beads on the applied markings.

Equipment for the application of transverse lines, longitudinal lines less than 200 feet in length, legends and symbols shall be either a hand wand attachment to a longitudinal line application vehicle, or a separate motorized trailer application system. Application equipment for short or transverse lines, legends, and symbols can be suitable for only one color.

709-3.02 Application:

(A) Placement Locations:

Dual component pavement markings shall be as shown on the plans, except that marking lines shall not be placed on parallel construction or expansion joints. Longitudinal lines shall be offset to provide a minimum of 1 inch of clearance from parallel construction and expansion joints unless otherwise directed by the Engineer.

(B) Material Inspection:

All dual component pavement marking materials and glass beads will be inspected and approved by the Engineer prior to their application. The contractor shall also provide samples of said materials if requested by the Engineer.

All materials shall be properly packaged and stored. Each container to be used on the project shall be clearly labeled to indicate the following information (as applicable):

(1) Nature, type, color and formulation of the material;
(2) Manufacturer, batch number and date of manufacture;
(3) Application requirements and constraints; and
(4) MSDS information.

Storage, preparation and application equipment shall be in accordance with the plans, specifications and the recommendations of the materials manufacturer.

The contractor shall dispose of excess materials, spilled materials, cleaning fluids and all empty material containers at a site approved by the Engineer.

(C) Equipment Inspections and Deficiencies:

The contractor shall make daily maintenance and operation inspections of all application equipment to ensure that it is operable with the requirements of the specifications. The contractor shall inform the Engineer of any equipment breakdowns, intermittent malfunctions or other conditions that may impact the proper application of specified markings. Any equipment judged to be unsuitable by the Engineer shall be repaired or replaced.

(D) Pavement Surface:

The contractor shall remove all dirt, dust, grease, oil or other detrimental material from the road surface prior to application of the dual component material.

Existing temporary or permanent traffic markings shall be removed by abrasive blasting or grinding until a minimum of 85 percent of the underlying pavement is visible, unless otherwise recommended by the materials manufacturer. The method of abrasive blasting and grinding is subject to approval by the Engineer. The contractor shall clean the surface by sweeping and with high-pressure air spray, unless otherwise recommended by the materials manufacturer. The contractor shall minimize any interference between temporary pavement markings and the permanent dual component pavement markings.

When dual component markings are to be applied to new Portland cement concrete pavement, any curing compound present shall be removed by means of a high-pressure water jet or sandblasting, followed by sweeping and high-pressure air spray. The curing compound shall be removed at least 1 inch beyond the width of the marking to be installed.

(E) Pavement Temperature and Condition:

Dual component pavement markings shall not be applied to new asphaltic concrete pavements for a minimum of 30 days after the pavement has been placed.

The roadway surface temperature at the time of application shall be a minimum of 40 degrees F and shall be rising. The air temperature and wind chill factor shall not be below 35 degrees F. Additionally, the road

surface shall be dry with no standing water or significant surface dampness or dew.

The pavement surface temperatures shall be measured one half hour prior to the start of the striping installation activities, and every one to two hours after that until the end of the day if the temperature is judged by the Engineer to be critical. For elevation changes greater than 1,000 feet, temperature readings at the highest elevation shall govern unless otherwise directed by the Engineer. The pavement surface temperature shall be measured with a standard surface temperature or an infrared non-contact thermometer. The Engineer may require temperature readings to be taken at shorter time intervals.

(F) Application Calibration Requirements:

Prior to the start of all marking application operations, the film thickness, width and bead application rates shall be calibrated as specified below in the presence of the Engineer. If at any time a condition changes, or the required application rates are not being achieved, the contractor shall repeat the calibration process if so directed by the Engineer.

(1) Film Thickness and Width Calibration for Longitudinal Lines:

The required application speed for the pavement marking vehicle shall be determined prior to the start of each day's marking operations.

The equipment needed to calibrate paint wet film thickness and width are a stopwatch, metal sample plates 4 by 12 inches minimum, wet film thickness gauge, measuring tape, and a roll of tar paper. The paint film application thickness, width and speed shall be calibrated using the following procedure:

Step 1 - A 30-foot length of 4 foot wide tar paper shall be rolled out and attached to the pavement in an area where the striping vehicle can achieve and maintain a speed of up to ten miles per hour without impacting traffic. The tar paper shall be secured to the pavement surface with duct tape so that it is laying flat. Three metal sample plates shall be placed 3 to 4 feet (apart and duct-taped down near the end of the 30-foot test distance.

Step 2 - The striping vehicle shall install a stripe, without glass beads, on the tar paper for the marked 30-foot distance and over the sample plates. The time that it takes the striping vehicle to apply the 30 feet (of test stripe shall be measured and then equated to a mile per hour application speed. Additionally, the velocity of the striping vehicle shall be noted by the driver. The contractor shall remove any test stripes which extend beyond the tar paper.

Step 3 - Immediately after the test stripe has been installed, the wet film thickness on all three metal plates shall be measured, as specified in ASTM D1212, using a wet film thickness gauge. The device shall be inserted into the wet paint to the depth of the metal, in accordance with the manufacturer's recommendations, and the thickness visually noted. If a wet thickness gauge is used, the manufacturer's directions shall be followed. The stripe distribution on the sample plates will be inspected for width, edge definition, and overall visual appearance.

Step 4 - Steps 2 and 3 shall be repeated until the optimum paint application speed, material flow settings, and sprayer heights are determined, and the atomizing pressures are established, such that an even clearly-defined stripe of the required width and thickness is produced.

Additionally, spot checks of the applied wet film thickness shall be made by the contractor throughout the day. Random spot checks of the paint thickness will also be made by the Engineer to ensure conformance with the required criteria. The contractor shall inspect the wet film thickness immediately after the marking paint is applied by inserting a wet film thickness gauge, with graduations of 0.001 inch into the wet paint to the depth of the pavement surface, in accordance with ASTM D1212. The thickness determined through spot checking shall be within 0.002 inches of the required thickness.

If the applied thickness is not within the tolerance specified above, or the width of the line is less than required, all striping operations shall stop, and adjustments shall be made such that the required thickness or width is achieved. If after three consecutive adjustments the required width or thickness are still not being achieved, all striping operations shall be halted and the contractor shall repeat the calibration procedures herein specified before striping operations can start again.

(2) Glass Bead Flow Calibration for Longitudinal Lines:

The glass bead application rates shall be calibrated at the beginning of each day's marking operation, after the marking paint application speed has been determined.

The equipment needed to calibrate the bead flow is a stopwatch, 1000-milliliter beaker graduated at 50-milliliter intervals, a bead calibration chart (available from glass bead manufacturers), and two 5-gallon buckets. The bead calibration charts shall equate the volume of beads measured through the calibration process to the required glass bead application rate in pounds per gallon of dual component marking paint applied. The chart shall also include the required application speed in miles per hour to achieve the specified glass bead application rate. The glass bead application rate shall be calibrated using the following procedure:

Step 1 - With the striping vehicle stopped and the paint sprayer off, place a bucket under the bead dispenser.

Step 2 - Turn the bead dispenser on for five seconds.

Step 3 - Pour the beads into the beaker and measure the volume.

Step 4 - Using the bead calibration chart for the required thickness of paint, find the required bead application rate, the measured volume of beads in the beaker, and the resulting application speed.

Step 5 - If the beaker volume is less than the chart value, increase the bead flow. If the beaker volume is more than the chart value, decrease the bead flow.

Step 6 - Repeat Steps 2 through 5 until the required speed for the specified bead application rate matches the required paint application speed as determined in Subsection 709-3.02(F)(1) of the specifications.

Once all application speed and settings have been calibrated, the contractor shall lay a test strip of the dual component paint marking at the specified width, thickness, and glass bead density. The test strip shall be placed on a 20-foot length of 4-foot wide tar paper, with two 4 by 12-inch sample plates spaced ten feet apart. The contractor shall provide the two sample plates from the test strip to the Engineer. The plates shall indicate the date, project number, project name, thickness, bead application rate and contractor name on the back. The Engineer may have these plates tested per the requirements of Subsection 709-2.02(J) of the specifications. All calibration activities shall be done in the presence of the Engineer.

(3) Thickness and Glass Bead Calibration for Transverse Markings, Symbols and Legends:

Calibration of thickness for transverse markings, symbols and legends prior to construction will not be required. The contractor shall inspect the wet film thickness immediately after the marking paint is applied by inserting a wet film thickness gauge, with graduations of 0.001 inch, into the wet paint to the depth of the pavement surface, in accordance with ASTM D1212. The thickness determined through spot checking shall be within 0.002 inches of the required thickness. Random spot checks of the marking thickness will also be made by the Engineer to ensure conformance with the required criteria.

Bead application rates shall be determined by pre-weighing, in a clearly marked container, the amount of beads required for each transverse marking, symbol or legend. The contractor shall determine the amount of beads required for each individual application, and provide documentation to the Engineer for approval prior to application.

(G) Marking Application:

The standard application thickness and bead gradations types and rates for dual component markings shall be as follows:

(1) Longitudinal Lines:

(a) Standard:

For asphaltic concrete pavements placed at elevations under 4,000 feet, dual component markings shall be 0.025 ± 0.002 inches thick with a bead application rate of 8 pounds of Type A glass beads per gallon of paint, followed immediately with 8 pounds of Type B glass beads per gallon of paint. For asphaltic concrete pavements placed at elevations equal to or above 4,000 feet, the thickness shall be the same; however, the bead application rate shall be 26 pounds of Type B glass beads per gallon of paint.

For PCCP pavements placed at elevations under 4,000 feet, dual component markings shall be 0.020 ± 0.002 inches thick with a bead application rate of 9 pounds of Type A glass beads per gallon of paint, followed immediately with 9 pounds of Type B glass beads per gallon of paint. For PCCP pavements placed at elevations equal to or above 4,000 feet, the thickness shall be the same; however, the bead application rate shall be 24 pounds of Type B glass beads per gallon of paint.

(b) Special (when shown on the bidding schedule):

For asphaltic concrete pavements placed at elevations under 4,000 feet, dual component markings shall be 0.020 ± 0.002 inches thick with a bead application rate of 9 pounds of Type A glass beads per gallon (of paint, followed immediately with 9 pounds of Type B glass beads per gallon of paint. For asphaltic concrete pavements placed at elevations equal to or above 4,000 feet (the thickness shall be the same; however, the bead application rate shall be 24 pounds of Type A glass beads per gallon of paint.

No reductions in thickness will be allowed for PCCP pavements.

(2) Transverse Lines, Symbols, and Legends:

The thickness of dual component pavement markings for transverse lines, symbols, and legends shall be 0.025 ± 0.002 inches with a bead application rate of 26 pounds of Type A beads per gallon of paint for all surfaces and at any elevation.

An epoxy application thickness of 0.025 ± 0.002 inches may be allowed on bridge decks if the majority of the project is AC pavement, and if approved by the Engineer. No additional payment will be made for the increased thickness if so allowed.

For longitudinal lines, the drop-on glass beads shall be mechanically deposited, at the specified rates, into the dual component marking material immediately after it is applied. The bead dispenser device shall evenly distribute the beads such that the top layer of beads are embedded in the surface of the marking to a depth of 50 to 60 percent of the bead diameter. Should the glass beads not adhere, or the top layer sink into the marking beyond the required embedment depth, operations shall be stopped until the problem has been corrected. All markings which do not meet the requirements of Subsection 709-2.02(J) of the specifications shall be removed and replaced by the contractor at no additional cost to the Department.

Transverse lines, longitudinal lines less than 200 feet in length, legends and symbols shall be applied with a hand wand attachment to a longitudinal line application vehicle, or with a separate motorized trailer application system. Pre-cut templates shall be used for all short or transverse lines, legends, and symbols, and shall provide neat and square marking edges. Beads shall be hand-applied, and shall be evenly distributed over the markings using pre-measured buckets.

The finished dual component marking line shall have well-defined edges and be free from waviness. Lateral deviation of the marking line shall not exceed 1 inch in 100 feet. The longitudinal deviation of a marking line and gap shall not vary more than 6 inches in a 40 foot cycle. The actual width of marking line shall be within the limits specified in the following table, according to the width of line called for on the plans:

Plan Width	Actual Width
4 inches	4 to 4-1/2 inches
8 inches	8 to 9 inches
Over 8 inches	± 1 inch

After application and sufficient drying time, the dual component marking shall show no appreciable deformation or discoloration under local traffic conditions in an air or road temperature ranging from -10 to + 180 degrees F. The drying time shall be defined as the minimum elapsed time, after application, when the dual component pavement markings shall have and retain the characteristics required herein, and after which normal traffic will leave no impression or imprint on the newly applied marking. Drying time for epoxy materials shall be defined as the no-track time as specified in Subsection 709-2.02(N) of the specifications.

The contractor shall protect the newly applied dual component pavement markings from traffic during the required drying time.

(H) Material Applied:

The contractor shall provide a full accounting of all marking material and glass beads applied. Prior to the start of striping operations and after the calibration procedures, the contractor shall provide the Engineer with a detailed quantity summary which specifies the gallons of marking material and pounds of glass beads needed to achieve the specified

marking configuration. The contractor shall record these quantities each day in a log book. The Engineer and contractor will monitor the quantity of beads and paint applied each day, and compare the values to the anticipated quantity. The quantities of paint and beads actually applied shall be within ± 5 percent of the anticipated calculated values for each day's striping operation. The contractor shall determine the cause of any larger variations, and make necessary corrections before the next striping application shift. The log book quantities shall be agreed on after each day, and signed and dated by both the contractor and the Engineer.

709-3.03 Sampling and Testing of In-Place Dual Component Pavement Marking Material:

(A) Thickness Testing:

Random spot checks of the dual component pavement marking thickness will be made by the Engineer to ensure conformance with the required criteria. Suggested spot check procedures include the following:

Wet: Thickness can be field tested immediately after the dual component marking is applied on a metal sample plate. The thickness will be tested using a wet film thickness gauge. The device shall be inserted into the wet dual component markings to the depth of the metal and visually noted. The manufacturer's directions for use of the gauge shall be followed. The plate should remain in place and not be moved before thickness testing is completed.

Dried: Thickness can be field tested by placing a small flat sheet of metal or duct tape with a known thickness immediately ahead of the striping apparatus. After striping, remove the sample and use a suitable measuring device, such as a caliper or micrometer, to determine the thickness of the dried marking.

Thickness will be tested at a minimum of two locations, randomly selected in any given mile, using the "Dried" method. The thickness measurement includes glass beads. Thickness sampling locations do not require reapplication over the gaps created when removing tape/plate.

Thickness will be measured with a digital caliper capable of measuring to the nearest thousandth of an inch.

(B) Retroreflectance Testing:

The Department will notify the contractor 72 hours prior to testing. Retroreflectance testing will be performed every 0.2 mile, with four readings taken at each location. The four readings will be taken randomly within a 10 foot section. The average of the four readings

shall be the result for that location. Should the average of these readings not meet the required retroreflectance values, a second test of four readings will be performed 50 foot forward from the failing test. The higher average value of the two tests will determine the results for that location. The Department will provide raw test results to the contractor.

Retroreflectance testing will be performed in the direction of traffic. On roadways where yellow stripes separate opposing traffic, testing is done in both directions (two locations per 0.2 miles, one in each direction).

Transverse and symbol markings will not be subject to retroreflectance testing.

Longitudinal lines less than 0.2 miles (such as 12 inch white turn lanes), regardless of length, must be tested. A single test of four readings shall be taken at the approximate midpoint of each line. Should the average of these readings not meet the required retroreflectance values, a second test of four readings will be performed at the approximate half way point between the midpoint and the end. The higher average value of the two tests will determine the results for that location.

All markings that fail to meet these minimums will require reapplication and retesting of striping materials. Reapplication shall start from the location of a passing test, across the failure area(s), to the next passing test location. For dual component sections applied on asphalt determined to be deficient in retroreflectance, a second application of 20 mils shall be applied. The reapplication does not require removal of the deficient section. For dual component applied on both PCCP and concrete bridge decks that are determined to be deficient in retroreflectance, the failing application shall be removed and reapplied.

Depending on the extent of failing pavement markings, it may not be practical to retest with the reflectometer. In that case, the Department may perform a visual nighttime inspection. If the striping appears as bright as or brighter than the adjacent striping that meets the required retroreflectance, the Engineer may accept the reapplication.

Should retests for the reapplication of dual component pavement markings fail to meet the required minimum retroreflectance, the contractor shall remove the entire stripe down to the road surface.

709-4 Method of Measurement:

Dual component white and yellow longitudinal pavement markings, and transverse markings such as cross-walks and stop bars, will be measured by the linear foot along the center line of the pavement stripe, and will be based on a 4-inch wide stripe. Skips in dashed lines will not be included in the measurement. Measurement for striping with a plan width greater or less than the basic 4 inches, as shown on the plans or directed by the Engineer, will be made by the following method:

$$\frac{\text{Plan Width of Striping, (inches) x Linear Feet}}{4 \text{ (inches)}}$$

Double marking lines, consisting of two 4-inch wide stripes, will be measured as two individual marking lines. Crosswalk lines, stop bars, stop lines, gore lines, cross hatch lines, chevron lines and railroad marking transverse lines will be measured for centerline length and adjusted for widths other than 4 inches, as defined above.

Dual component pavement marking symbols, such as a diamond, or single, double, or triple arrow, will be measured by the unit applied. Each pavement symbol, as shown on the plans, will be considered a unit.

Dual component pavement marking legends, defined as a complete letter grouping such as "SCHOOL," "XING," "STOP," “RR,” or "ONLY," will be measured by each unit applied. Each pavement legend, as shown on the plans, will be considered a unit.

No separate measurement or payment will be made for cleaning the surface, including sweeping and high-pressure air spray; or for calibration of the bead and paint application rates; or for disposal of excess materials, cleaning fluids, and empty material containers; the costs being considered as included in the contract items.

Removal of curing compound from new Portland cement concrete pavement will be measured along the centerline of the line of curing compound being removed or by the unit each for symbols and legends, as appropriate. Measurement of a line of removal of curing compound will be based on a 4-inch wide line, and shall be measured by the linear foot, and in accordance with the items of work established in the bid schedule. Measurement for lengths of removal of curing compound with a plan width greater than 4 inches as shown on the plans or directed by the Engineer will be made by the same method and then adjusted by the following factor:

$$\frac{\text{Plan Width (inches) x Linear Feet}}{4 \text{ (inches)}}$$

The plan width will include an extra 4 inches – 2 inches on each side – beyond the plan width of pavement marking and will be based on a continuous length of pavement marking lines unless indicated on the project plans.

The cost for abrasive-blasting and grinding existing markings, not including temporary paint or tape lines, shall be paid for under separate items. No separate payment will be made for removing temporary paint or tape lines, the cost being considered as included in contract items.

709-5 Basis of Payment:

The accepted quantities of dual component pavement markings of the type specified in the bidding schedule, measured as provided above, will be paid for at the contract unit price, complete in place, including pavement surface preparation and glass beads.

The accepted quantities for removal of curing compound from new Portland cement concrete pavement, measured as provided above, will be paid for at the respective contract unit prices, under the items of work established in the bid schedule.

SECTION 710 SMART WORK ZONE SYSTEM:

710-1 Description:

The work under this section shall consist of furnishing and installing a fully functional, automated, and portable Smart Work Zone (SWZ) system; operating, maintaining, and servicing the portable SWZ system; and relocating and removing various components of the system, as specified herein and in accordance with the project plans and specifications.

710-1.01 Abbreviations:

Wherever the following abbreviations are used in these specifications, the contract, or in other contract documents, they are to be construed the same as the respective expressions represented:

CCTV	Closed-Circuit Television
CMB	Changeable Message Board
DMS	Dynamic Message Sign
DLMS	Dynamic Lane Merge Subsystem
FMS	Freeway Management System
GPS	Global Positioning System
GPSLS	Global Positioning System Location Sensor
GUI	Graphical User Interface
O&M	Operations and Maintenance
PDA	Power Distribution Assembly
PTZ	Pan, Tilt, and Zoom

QWS	Queue Warning Subsystem
SAB	Smart Arrow Board
SFS	Speed Feedback Sign
SWZ	Smart Work Zone
TCP	Traffic Control Plan
TDC	Traffic Data Collection
TDCS	Traffic Data Collection Subsystem
TEES	Truck Entry/Exit Subsystem
TMCS	Traffic Monitoring Camera Subsystem
TOC	Traffic Operations Center
TTS	Travel Time Subsystem
VSL	Variable Speed Limit
VSLS	Variable Speed Limit Sign
WZDx	Work Zone Data Exchange

710-1.02 Definitions:

Wherever the following definitions are used in these specifications, the contract, or in other contract documents, the intent and meaning shall be interpreted as follows:

(A) SWZ System:

The SWZ system is a broad range of portable communications-based information and electronic technologies placed in and around work zones to enhance transportation and improve safety and mobility. The real-time information and automation provided by the SWZ system is used by contractors and transportation agencies to alter traffic control strategies and provide traveler information to better inform motorists of upcoming traffic conditions, allow motorists the opportunity to alter their travel routes, and/or modify the travel behavior within work zones. The SWZ system is comprised of one or multiple SWZ subsystems that operate together.

(B) SWZ Area:

The SWZ area is the area where SWZ field devices are deployed near, within, and/or around the project and work zone limits.

(C) Active Work Space:

The active work space is the area that is anticipated to have the largest concentration of field personnel within the work zone during a specific day or construction shift. The personnel working in active work space are exposed to the dangers of an errant vehicle.

(D) Work Zone:

The work zone is the entire area in which traffic control, which includes, static signs and SWZ field devices, are implemented.

(E) Traffic Data Collection Subsystem (TDCS):

The TDCS is a component of the SWZ system that is capable of detecting, processing, and disseminating real-time traffic information such as vehicle speeds, traffic volumes, and travel time/delay within and in advance of the work zone for use by other SWZ subsystems, third-party traveler information systems, and/or to archive work zone traffic conditions. This subsystem could also include the use of third-party data, solely, or in combination with site specific gathered data.

(F) Queue Warning Subsystem (QWS):

The QWS is a component of the SWZ system that uses the real-time TDCS information to determine traffic queue lengths. The QWS warns approaching travelers of slowed or stopped traffic conditions through warning messages displayed on SWZ CMBs. When a queue begins to form, the QWS automates the display of warning messages on the associated SWZ CMB displays located in advance of the anticipated queueing areas. The QWS also alerts field personnel and remote SWZ system operators of the real-time queueing conditions.

(G) Dynamic Lane Merge Subsystem (DLMS):

The DLMS is a component of the SWZ system that uses the real-time TDCS information and SWZ CMBs, in advance of a lane closure, to instruct approaching travelers when to merge. When traffic volumes are high or a potential queueing condition is detected by the DLMS, the DLMS automates the display of messages that instruct drivers to merge later. When traffic volumes are low and a potential queueing condition is not detected in advance of the lane closure, the DLMS automates the display of messages that instruct drivers to merge earlier.

(H) Travel Time Subsystem (TTS):

The TTS is a component of the SWZ system that uses the real-time TDCS information and SWZ CMBs, in advance of the work zone, to determine the approximate travel time between the SWZ CMB location and another fixed point as shown on the project plans, or at the end of the work zone. The TTS automates the display of messages on each CMB to inform the drivers of the associated travel time (at predetermined locations) through the work zone. In addition, the TTS is capable of comparing real-time TDCS information to historical travel time information to estimate the approximate travel delay that a driver can expect, when traveling through the work zone.

(I) Traffic Monitoring Camera Subsystem (TMCS):

The TMCS is a component of the SWZ system that uses closed-circuit television (CCTV) cameras to provide real-time video streams that are monitored on-site by field personnel using a mobile display device and/or remotely by the Engineer, Traffic Operations Center (TOC) operators, and the District to view real-time roadway traffic conditions within the work zone.

(J) Variable Speed Limit (VSL) Subsystem:

The VSL subsystem is a component of the SWZ system that uses TDCS real-time traffic information and variable speed limit signs (VSLS) to dynamically reduce or increase regulatory speed limits in the work zone. Regulatory speed limits are dynamically reduced in the active work space. Regulatory speed limits are dynamically increased within the same area of the work zone when the construction personnel are not present.

(K) Truck Entry/Exit Subsystem (TEES):

The TEES is a component of the SWZ system that uses the real-time TDCS information to determine the entry of construction vehicles to the roadway from the work area and warns approaching travelers of slow-moving vehicles ahead. The TEES may warn drivers by displaying a message on a SWZ CMB or by illuminating flashing warning lights attached to a static sign. Once the construction vehicle has entered the roadway and a pre-determined amount of time has passed, the TEES no longer displays the warning message until it detects another construction vehicle entering the roadway from the work area. The TEES also alerts the field personnel and remote SWZ system operators when the system is activated.

(L) SWZ System Software:

The SWZ system software is a software platform that can receive, store, analyze, send, and display real-time information from the TDCS, QWS, DLMS, TTS, TMCS, TEES and VSL subsystem field devices, Department furnished data from roadway sensors, or other third-party sources. The SWZ system software provides the required automation, GUI, user

device applications, and system reports required to operate and maintain each respective SWZ subsystem deployed within the SWZ area.

710-2 Materials (Equipment, Workers, Devices and Facilities):

The SWZ system shall contain the selected SWZ subsystems including all necessary auxiliary field device equipment, the SWZ system software for each selected SWZ subsystem, the communications and third-party data services, system operations, maintenance, and support services to provide a complete SWZ system. The selected SWZ subsystems may consist of one or more of the following: TDCS, QWS, DLMS, TTS, TMCS, TEES, VSL, or other type of subsystem as indicated on the plans or specifications.

The auxiliary field device equipment shall include all appurtenances such as traffic detectors, changeable message boards, CCTV cameras, variable speed limit signs, static SWZ signs, device trailers, mounting assemblies, communications and geolocating devices, power assemblies, wiring, and accessories.

The communications services shall include all services needed for connecting the field devices to the remote SWZ system software and connecting the SWZ system software to the internet and communications service provider networks that the system users and Department representatives have access to for connectivity into the SWZ system.

The system operations, maintenance, and support services shall include all services required to deploy, integrate, configure, test, operate, and maintain the SWZ system communications and geolocating devices, third-party data services, field devices, and software for continuous operations in and around the project work zones.

710-2.01 General Requirements:

The contractor shall submit the SWZ system and the associated field devices as part of the TCP and safety plan.

Except as specified herein, all equipment, procedures used by workers, devices, and facilities shall conform to the requirements of Subsection 701-2 of the specifications.

(A) Documentation:

The contractor shall submit a SWZ material proposal at the preconstruction conference or when reasonably feasible. If the contractor's SWZ material proposal is not submitted at the preconstruction conference, each SWZ subsystem submittal shall be shown in the work schedule.

The contractor's SWZ material proposal shall include the following and any other necessary documents to fully describe the proposed SWZ subsystems and field device items:

(1) Certificate of Compliance:

A Certificate of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for each SWZ subsystem assembly. The Department reserves the right to require Certificates of Compliance for the subsystem functionality provided within the SWZ system software, for each field device assembly component, and for third-party data sources.

The Department reserves the right to perform independent evaluations or tests on any SWZ System Software, equipment, or service supplied by the contractor in the work zone.

(2) SWZ Technician Credentials:

The credentials of the contractor's designated SWZ technician(s) skilled in the operation of all the SWZ system equipment and software shall be submitted to the Engineer for approval. There shall be a designated SWZ technician for each shift of work and the qualifications of the designated technician(s) shall demonstrate the following:

(a) The technician is locally available while the SWZ system is in use and able to respond to the SWZ system issues in person within one hour of notification.

(b) The technician has the training and experience necessary to perform all SWZ field equipment deployments, device configurations, system testing, trouble shooting, maintenance, and component level repair or replacement.

(c) The technician is employed by a contractor that has a minimum of 3 years of experience deploying SWZ technologies on projects with roadway construction valued at one million dollars or more, or has relevant experience that is approved by the Engineer.

If the contractor would like to replace one or more SWZ technician(s), then the new technician(s) shall be approved by the Engineer prior to assuming these duties on the project.

(3) Communications Site Assessment:

A communications site assessment shall be submitted to the Engineer for approval at least six weeks before mobilizing field equipment for deployment in the project area. The communications site assessment

shall identify the specific communications service(s) that the contractor has selected for connecting the field devices to the remote SWZ system software and for documenting the contractor's approach for verifying these communications services are available within the project limits.

The results of this communications site assessment shall be summarized and indicate that the selected communications approach(es) provides sufficient data network capacity and coverage needed for proper SWZ system operations within and in advance of the work zone.

(4) System Configuration Plan:

The contractor shall submit a SWZ system configuration plan to the Engineer for approval at least six weeks before mobilizing field equipment for deployment in the project area. The plan shall describe the system logic and field device layout concepts to be used. The SWZ system configuration plan shall demonstrate the following:

(a) The general deployment locations of each subsystem element within the SWZ area such as, but not limited to, TDC, CMB assembly, VSLS assembly, traffic monitoring camera assembly, SAB assembly, SFS assembly, GPSLS assembly, and auxiliary SWZ equipment for each type of anticipated TCP. The plan shall include the role played by each of these device locations in the overall deployment concepts of the SWZ system.

(b) The operational logic used for each required SWZ subsystem (i.e., TDCS, QWS, DLMS, TTS, TMCS, TEES and VSL) that describes the system's response when various traveler information and system logic thresholds are reached. This shall include, but is not limited, to the following:

(i) Systems that generate alert messages, how the alert messages are received (via text and email), and the Department representatives that will receive the alert messages.

(ii) System logic configuration thresholds, limits, controls, and display messages that have been coordinated with the Department for initial system configuration.

(iii) Configuration thresholds, limits, controls, and display messages that can be changed by system users via the SWZ software interface, and system safeguards that are in place to limit the ranges and messages that are selectable by these system users.

(c) Documentation and specification details for the deployed devices that support access or receipt of the WZDx information.

(5) SWZ System Operations and Maintenance Plan:

The contractor shall submit a SWZ system O&M plan to the Engineer for approval at least four weeks before mobilizing field equipment for deployment in the project area. The SWZ system O&M plan shall identify the contractor's means and methods for deploying, operating, and maintaining the SWZ system equipment and software. The SWZ system O&M plan shall demonstrate the following:

(a) A qualified SWZ technician locally available and assigned for every work shift. Contact information shall be provided for each SWZ technician so that the Engineer can notify the technician(s) of a SWZ system issue and the SWZ technician can respond to the SWZ system issue in person within one hour of notification.

(b) A customer support phone number, email address, and days/hours of support provided for the SWZ system software and each associated subsystem.

(c) A process in place for maintaining continuous operations of SWZ field devices, including but not limited to:

(i) Replacing batteries as needed.

(ii) Refueling fuel tanks before the fuel runs out.

(iii) Moving equipment to keep pace with moving or changing construction activities, changing traffic queuing conditions, TCP changes, or as directed by the Engineer or contractor.

(iv) Adjusting SWZ system software configurations, setting different software logic thresholds and limits, setting days/times and system activities with the software scheduler, selecting different display messages to be posted on the SWZ CMB, changing user alerts and recipients receiving the alerts, changing system software users and levels of access, and making changes to the system logic, configuration, and users in general.

(v) Maintaining a SWZ system equipment maintenance log for all associated O&M activities.

(vi) Repairing or replacing equipment that has been damaged, stolen, or has become an inoperable component of the overall SWZ system.

(6) SWZ Software User Training Curriculum Outline and Schedule:

A SWZ Software User Training Curriculum Outline and Schedule shall be submitted for each SWZ subsystem assembly. The training curriculum and contractor provided training shall reflect the actual needs of the Department's system users and field personnel and include the following sections:

(a) Theory of Operation

(b) Field Device Layout Concepts and Associated Data Collection

(c) System Logic, Limits, and Safeguards

(d) GUI and Operating Procedures

(e) System User Access Levels and Permissions

(f) System Alerts and Types of Alert Messages

(g) Generating System Data Reports and Graphics

(h) SWZ Software Customer Support Services

(i) Procedures for Reporting Concerns or Requesting Changes with the SWZ Software Configuration and Field Device Deployments

The contractor shall coordinate with the Engineer to identify mutually agreed upon training dates and times for each training class.

(7) SWZ Software User Access Privileges and Alert Messages:

The contractor shall coordinate with the Engineer and provide a SWZ User Access Privileges submittal that clearly identifies each Department user by first and last name and the associated level of access that each of these users will have when logging into the system.

The contractor shall coordinate with the Engineer and provide a SWZ Alert Messages submittal that clearly identifies each Department stakeholder by first and last name, the associated types of system generated alerts they will receive and the method (email or text) the alert is received.

(8) SWZ System Data Reports:

The contractor shall submit an example set of each required SWZ system data report to the Engineer for approval at least two weeks before deploying SWZ field equipment in the project area. The example set shall demonstrate the contractors proposed format for each report, the types of data included within each report, the frequency of the data within the report (i.e., once per minute, five minutes, etc.), and the time period to by covered by each individual report (i.e., each report represents a days' worth of data, a weeks' worth of data, etc.). The SWZ system data reports shall be submitted on a weekly basis, in the approved format, and contain the actual work zone data collected during that week of SWZ system deployment.

In accordance with the ADOT Work Zone Safety & Mobility Policy, to monitor and measure work zone impacts during construction, the SWZ system data report shall include the following sets of data:

(a) Travel delay
(b) Queue lengths
(c) Crash occurrences

Each SWZ system data report shall include the geolocation(s) that the data is associated with.

If the intelligence of the SWZ subsystem(s) required in the project plans and specifications does not generate the above sets of data and the associated reports, then the SWZ system provided shall have the ability to support manual entry of this data and the ability to archive and generate reports of the manually entered data.

The contractor's SWZ system data reports shall include any other information that may be required for each type of SWZ subsystem deployed.

(9) Subsystem Acceptance Testing Procedures:

A system acceptance testing procedures submittal shall be submitted for each SWZ subsystem assembly to demonstrate proper operation of all subsystems and device configurations. The testing procedures shall include the following:

(a) Initial System and Device Testing:

Initial system and device testing is intended to demonstrate that each subsystem component provided and its associated configurations for the project work zone successfully achieves all of the required functionality, performance, and reporting requirements.

(b) Individual SWZ Field Device Location Testing:

Individual SWZ field device location testing is intended to verify that a specific field device is configured correctly, communicating, and operating properly when moved in the SWZ area after initial system setup.

(10) Certificate of Analysis:

A Certificate of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for each SWZ subsystem assembly each time the contractor deploys an associated field device component and completes the associated tests in accordance with the approved subsystem acceptance testing procedures.

(B) Auxiliary SWZ Equipment:

Auxiliary SWZ equipment is considered incidental components that may be required to achieve a fully functional SWZ system. The following are some common types of auxiliary equipment and their associated minimum requirements:

(1) SWZ System Communications:

All SWZ systems shall provide the necessary communications devices and services to connect the field devices to the remote SWZ system software and to connect the SWZ system software to the internet and communications service provider networks. The SWZ system communications shall provide continuous service to the devices of the system operators, users, and Department representatives.

The SWZ system communications devices and services provided shall be in accordance with the approved communications site assessment, as described in Subsection 710-2.01(A)(3) of the specifications. The SWZ system communications devices and services shall provide sufficient data network capacity and coverage needed for proper SWZ system operations within the SWZ area.

(2) Safety Protocols for Smart Devices:

All SWZ systems shall be deployed in accordance with the following safety protocols for smart devices:

(a) Each device shall be up to date prior to being deployed with latest release of operating system (OS)\firmware and relevant security patches. Update releases shall be tracked and deployed routinely to keep device OS\firmware current.
(b) WiFi networks in use shall only be configured to use WPA2 PSK w/ AES and use complex passphrases; diceware passphrases are preferred and rotating pass-phrases is a good practice.
(c) SNMP capabilities shall be disabled if not intended for use; SNMPv3 shall be configured for use if SNMP is needed (when device is capable).
(d) Syslog shall be configured and used to monitor deployed devices.
(e) Telnet shall be disabled, SSH shall be enabled and restricted to SSHv2 only. Keys used for encryption shall be at least 2048 bit.
(f) Trusted Certificate Authority generated SSL\TLS certificates shall be used on web management UIs to ensure end to end encryption. If possible, the following SSL\TLS version, SSLv 1, 2, 3, and TLS v1.0,1.1 shall be disabled.
(g) The use of strong ciphers shall be required for both TLS and SSH encryption, any medium or low strength ciphers (i.e. RC4, DES\3DES, etc.) shall be disabled or kept at a lower priority.
(h) Default\built-in account usernames and passwords shall be changed to follow complexity settings. (e.g. default admin). If possible, these built-in accounts shall be disabled.
(i) Users or administrators shall be provided with unique accounts for login purposes and shall be configured to comply with the following complexity settings, when the device is capable:
    (i) Previous 24 passwords remembered and can't be re-used
    (ii) 30-day maximum password age before resetting is required
    (iii) 15 character minimum length (Diceware pass phrase preferred)
    (iv) Passwords must use at least 2 numbers and 2 special characters
    (v) Must be stored encrypted, and cannot be stored using reversible encryption
    (vi) Account must be locked-out for 30 minutes upon 3 invalid logon attempts

(j) The gateway (i.e., cell modem/router) that is handling the remote communications to the local smart devices shall be secured by setting up firewall rules so that the gateway communicates only with the pre-defined devices, known trusted IP addresses, and keeps out unauthorized traffic.

(3) Geolocation of SWZ System Devices and Information:

The geolocation of intelligent field devices and data sets reported shall be provided using a GPS device accurate within 3 meters (9.84 feet) of the actual location or by some other method for geolocating devices and information, as approved by the Engineer. The GPS device used for the TDC, CMB, VSLS, traffic monitoring camera, SAB, SFS, and intelligent field device assemblies, shall be considered auxiliary SWZ equipment that is incidental to these device locations. The GPSLS assembly is a standalone GPS device location and shall not be considered an auxiliary integral part of any other intelligent field device.

All SWZ systems shall provide a GUI that displays the actual deployed location of each intelligent device, including the standalone GPSLS assemblies, that is communicating with the SWZ system software using the approved geolocating method.

All third-party information used by the SWZ system software and used within SWZ system data reports shall include the geolocation(s) associated with the information provided.

(4) SWZ Field Device Power Supply:

All SWZ system field devices shall be independently powered and shall be powered for operation continuously during all deployment periods within the SWZ area and shall be provided with a means for alerting remote system users and operators of a low power or loss of power condition.

The SWZ system shall have the ability to archive and generate reports on power condition alert messages received from SWZ system field devices deployed within the SWZ area. This archived data shall include the associated device name and number and shall include the date and time of each alert message.

All power supplies shall have capacity to support at least 72 hours of continuous operation. Examples of acceptable power supplies include:

(a) Battery Powered Devices: The contractor shall replace batteries and equipment as necessary for continuous SWZ system operations in accordance with the approved SWZ system O&M plan.

(b) Solar Power Distribution Assemblies: The contractor shall clean and adjust the position of solar panels and replace equipment as necessary for continuous SWZ system operations in accordance with the approved SWZ system O&M plan.

(c) Gas and Liquid Fuel Powered Devices: The contractor shall replace fuel and equipment as necessary for continuous SWZ system operations in accordance with the approved SWZ system O&M plan.

(5) Portable Field Device Trailers:

When SWZ system field devices are mounted to portable trailers deployed within the SWZ area the portable trailers shall meet the following requirements:

(a) Trailer Number: All trailers deployed within the SWZ area shall have a trailer number that is easily visible from the first vehicle travel lane adjacent to the deployed trailer. All trailers deployed in the SWZ area shall have different numbers to uniquely identify and differentiate one trailer from another.

(b) Towing Support: The trailers shall be street legal, have functioning brake lights when being towed, support driving speeds up to 65-mph when being towed, and be equipped with a standard size trailer hitch.

(c) Leveling Legs: The trailers shall have adjustable leveling legs that can support the weight of a fully loaded trailer with the tires removed. The adjustable height of the legs should be able to raise the trailer wheels a minimum of four inches between the bottom of the wheels and a flat/level surface that the trailer is standing on. Each leg shall be independently adjustable to support leveling the base of the trailer when deployed on a sloped area.

(d) Wind Loading: With all stabilizing devices in place, the fully loaded trailer shall be capable of withstanding wind gusts up to 80-mph without overturning or changing orientation.

(e) Display Tile Angle Adjustments: When mounting brackets are provided for CMBs and VSLSs, they shall be provided with the ability to adjust the tilt angle of the display board in accordance with the

display board manufacturer's recommendations for the optimal viewing angle.

(f) Pole Rotating Adjustments: When fixed-height or telescoping poles are provided to increase the mounting height of cameras and traffic detection devices, they shall be provided with the ability to rotate the pole, from ground level, in support of adjusting the horizontal viewing/detection angle of the device(s) mounted towards the top of the pole.

(g) Equipment Enclosures: When equipment enclosures are provided to house electronic communications, geolocating devices, local processing devices, batteries, and other PDA components, they shall be provided with security provisions to deter and delay theft of equipment inside the housing.

(6) Static Traffic Control Devices for SWZ Field Equipment:

Static traffic control devices for SWZ field equipment shall consist of furnishing, installing, maintaining, moving and removing barricades, warning signs, cones, and other traffic control devices, per the approved traffic control plans, through or around the SWZ system field device locations deployed in or adjacent to the work zone. The static traffic control devices for SWZ field equipment shall be provided in accordance with the requirements of Part VI of the current edition of the Manual on Uniform Traffic Control Devices (MUTCD) and the current edition of the associated ADOT MUTCD supplement.

710-2.02 SWZ Traffic Data Collection (TDC) Location:

Each TDC location shall be equipped with all detecting, processing, and disseminating equipment and functionality needed to deliver real-time traffic information. The traffic data collected, shall be practicable for the SWZ subsystem identified such as vehicle speeds, traffic volumes, and occupancy within an area of the roadway that provides a single direction of travel with one or more travel lanes for that location. If required in the project plans or special provisions, additional traffic data shall be collected for vehicle classification and all data shall be collected "per lane". Each TDC location shall include all of the equipment necessary to provide a fully functional component of the SWZ system.

A minimum of two TDC locations shall be provided to generate the required travel time and travel delay traffic information; unless a third-party traveler information system is used to provide the travel time/delay for the location (i.e. a single route between two or more points).

All TDC locations shall provide the SWZ system software the following information:

(A) Vehicle speeds averaged together within a maximum time interval of one-minute.

(B) Traffic volume count for each one-minute time interval.

(C) Travel time and delay information for each one-minute time interval, computed by the TDC locations, or computed by the SWZ system software based on the per minute data provided by the TDC location(s).

(D) For each location that has multiple travel lanes, the traveler information provided shall be a representative sample of all travel lanes combined as one for the same direction of travel.

(E) All real-time traffic information provided to the SWZ system shall be time stamped with the actual date and time, with a tenth of a second accuracy, for each one-minute time interval sent to the SWZ system software.

Each TDC location deployed within the SWZ area shall have a number to uniquely identify that location and differentiate it from all other TCD locations. When the TDC location is comprised of field traffic sensor(s) the location number shall be displayed within the SWZ system software and shall be easily visible by field personnel at the location were the device(s) are mounted. When the field traffic sensors are mounted on a portable field device trailer the TDC location number used shall be the same number that is visible on the trailer.

When third-party data is used to collect the traffic data, the location number only needs to be displayed within the SWZ system software to identify each location where the data is being collected. When third-party data is used to collect travel-times between two locations, a unique route number shall be used to identify the location of each different route.

All TDC locations shall provide additional traveler information, as necessary, to achieve the functionality of other SWZ subsystems required by the project plans and specifications.

710-2.03 SWZ Changeable Message Board (CMB) Assembly:

Each SWZ CMB assembly shall be equipped with a changeable message display board and all processing and disseminating equipment, and have the functionality required to deliver automated messages generated by the SWZ system software to the travelling public via the message display boards of the SWZ CMB assembly. Each SWZ CMB assembly shall include all of the equipment necessary to provide a fully functional component of the SWZ system.

Each SWZ CMB assembly shall be provided and deployed in accordance with the MUTCD requirements for portable changeable message signs (MUTCD Section 6F.60) and the following:

(A) The SWZ CMB shall support the display of three lines of eight characters per line or should consist of a full matrix display.

(B) The letter height used for SWZ CMB messages should be a minimum of 18 inches, unless deployed on low speed facilities (40-mph or less). Shorter letter sizes may be used for SWZ CMB messages when deployed on low speed facilities provided that the message is legible from at least 650 feet.

(C) Under low light level conditions, the SWZ CMB shall automatically adjust its light source to meet the MUTCD legibility requirements and not impair the driver's vision.

(D) The SWZ CMB shall be provided with a default message state that is used when communications with the SWZ system software are lost for a predetermined amount of time. The default message state shall support the following options:

(1) A blank display with no message,

(2) A pre-approved message for the project and location, and

(3) Continue to display the last message received from the SWZ system software.

(E) The SWZ CMB shall be provided with local manual override controls. When the local manual override controls are used, the SWZ CMB shall:

(1) Display only traffic operational, warning, and guidance information, and shall not be used for advertising messages.

(2) Display messages that consist of no more than two phases, and a phase should consist of no more than three lines of text. Each phase should be capable of being understood by itself, regardless of the order in which it is read. Messages should be centered within each line of the legend. If more than one portable SWZ CMB is simultaneously legible to road users, then only one of the signs should display a sequential message at any given time. Each phase shall have a display time of at least two seconds and the sum of the display times for both of the phases should be a maximum of eight seconds.

Each SWZ CMB assembly deployed within the SWZ area shall have a unique number to identify that location and differentiate it from other SWZ CMB locations. When the SWZ CMB assembly is mounted on a portable field device trailer the SWZ CMB assembly number used shall be the same number that is visible on the trailer.

710-2.04 SWZ Traffic Monitoring Camera Assembly:

Each traffic monitoring camera assembly shall be provided with all cameras, video processing and disseminating equipment, and functionality needed to provide real-time viewing of traffic and roadway conditions, from a remote location and through the SWZ system software. Each SWZ traffic monitoring camera assembly shall provide the ability to view all approaching directions of the roadway, relative to the camera assembly deployment location, using one or more cameras mounted at an appropriate mounting height for viewing the roadway and traffic conditions. Each SWZ traffic monitoring camera assembly shall include all of the equipment necessary to provide a fully functional component of the SWZ system.

All SWZ traffic monitoring camera assembly locations shall provide the following camera functionality:

(A) Ability to provide a video stream from each camera that can be viewed remotely from the SWZ system software GUI interface display window.

(B) Ability to adjust the field of view (i.e., pan, tile, and zoom) of each camera, remotely from the SWZ system software, locally at the camera assembly location, or both.

(C) Ability to support both daytime and nighttime operations. During daytime operations a color video stream shall be provided. During nighttime operations the camera shall function in low light conditions and support color, black-and-white, or both types of video streams.

(D) Ability to adjust the camera iris and focus manually, via auto-Iris and auto-focus functionality, or both.

(E) Ability to set and select camera pre-set positions, one for each approaching direction of the roadway, relative to the camera assembly deployment location, when a pan-tile-zoom functionality is provided for remote operations.

(F) Ability to adjust the mounting height of each camera.

Each traffic monitoring camera assembly location deployed within the SWZ area shall have a unique number to identify that location and differentiate it from other traffic monitoring camera assembly locations. When the traffic monitoring camera assembly is mounted on a portable

field device trailer the traffic monitoring camera assembly location number used shall be the same number that is visible on the trailer.

710-2.05 SWZ Variable Speed Limit Sign (VSLS) Assembly:

Each VSLS assembly shall be provided with a changeable message display board for posting regulatory speed limits and all processing and disseminating equipment and functionality needed to deliver SWZ system software generated speed limits to the traveling public via the changeable message display board of the VSLS assembly. Each VSLS assembly shall include all equipment necessary to provide a fully functional component of the SWZ system.

Each VSLS assembly shall be provided and deployed in accordance with the MUTCD requirements for Regulatory Speed Limit Signs (MUTCD Section 2B.13) and the following:

(A) The VSLS display shall be the R2-1 sign type, per the MUTCD, with white colored lighted pixels that display the speed limit message on a black background.

(B) The speed limits shall be displayed in multiples of 5 mph.

(C) Under low light level conditions, the VSLS display shall automatically adjust its light source to meet the MUTCD legibility requirements and not impair the driver's vision.

(D) The VSLS display shall be provided with a default message state that is used when communications with the SWZ system software is lost for a predetermined amount of time. The default message state shall support the following options:

(1) Blank display with no speed limit message,

(2) Pre-approved speed limit message for the project and location, and

(3) Continue to display last speed limit message received from the SWZ system software.

(E) The VSLS assembly shall be provided with local manual override controls. When the local manual override controls are used, the VSLS display shall:

(1) Only display speed limits in multiples of 5 mph, and

(2) Provide a blank display with no speed limit message when moving the sign to a new deployment area.

(F) A "VARIABLE SPEED ZONE AHEAD" warning sign shall be used in advance of the first VSLS location deployed to inform road users of a variable speed limit zone where the speed limit may be reduced by more than 10 mph. The Variable Speed Zone Ahead warning sign shall be a similar shape, size, and color to the Reduced Speed Limit Ahead (W3-5) or XX MPH Speed Zone Ahead (W3-5a) sign type of the MUTCD.

(G) An "END OF VARIABLE SPEED ZONE" sign shall be used after the last VSLS location deployed to inform road users that the variable speed limit zone has ended. The End of Variable Speed Zone warning sign shall be a similar size and color to the Reduced Speed Limit Ahead (W3-5) or XX MPH Speed Zone Ahead (W3-5a) sign type of the MUTCD.

(H) A warning beacon shall be used in combination with a "VARIABLE SPEED ZONE AHEAD" warning sign and the "END OF VARIABLE SPEED ZONE" warning sign when required in the project plans and specifications. When required, warning beacons shall comply with the MUTCD (Section 4L.03).

Each VSLS assembly deployed within the SWZ area shall have a unique number to identify that location and differentiate it from other VSLS locations. When the VSLS assembly is mounted on a portable field device trailer the VSLS assembly number used shall be the same number that is visible on the trailer.

710-2.06 Smart Arrow Board (SAB) Assembly:

Each SAB assembly shall be provided with an arrow board for indicating lane closures all processing and disseminating equipment and functionality needed to SWZ system software generated arrow, chevron symbols and patterns as described in the MUTCD and these specifications. Each SAB assembly shall include all equipment necessary to provide a fully functional component of the SWZ system.

Each SAB assembly shall be provided and deployed in accordance with MUTCD Section 6F.61 and the following:

(A) The SAB assembly shall provide the functionality for the user to identify the GPS coordinates of the SAB assembly through the SWZ system software GUI. Changes in the GPS coordinates of the SAB shall be logged within the SWZ system software with a timestamp.

(B) The SAB assembly shall provide the functionality for the user to identify the display state of the SAB assembly through the SWZ system software GUI. Changes in the display state of the SAB shall be logged within the SWZ system software with a timestamp.

(C) The SAB display shall be provided with a default display state that is used when communications with the SWZ system software is lost for a predetermined amount of time. The default message state shall support the following options:

(1) Blank display with no chevron, arrow, or other pattern,

(2) Sequential chevron pattern, and

(3) Continue to display the last display state received from the SWZ system software.

(D) The SAB assembly shall be provided with local manual override controls. When the local manual override controls are used, the SAB display state shall conform to the MUTCD and these specifications.

Each SAB assembly deployed within the SWZ area shall have a unique number to identify that location and differentiate it from other SAB locations.

710-2.07 Speed Feedback Sign (SFS) Assembly:

Each SFS assembly shall be provided with a static speed limit sign, a changeable message display, and all processing and disseminating equipment and functionality needed to detect and display the speed of approaching vehicles. Each SFS assembly shall include all equipment necessary to provide a fully functional component of the SWZ system.

Each SFS assembly shall be provided and deployed in accordance with the MUTCD requirements for Regulatory Speed Limit Signs (MUTCD Section 2B.13) and the following:

(A) The static sign display shall be the R2-1 sign type, per the MUTCD, with white background and black legend. The pixels of the changeable message display shall be white on a black background.

(B) The changeable message display shall be two digits displayed in miles per hour with character height of 24 inches at a minimum.

(C) The changeable message display shall have the ability to:

(1) Continuously show the speed of an approaching vehicle and not flash regardless of speed limit or preset thresholds.

(2) Display a blank message if the detected vehicle speed is between 0% and 50% of the predetermined speed limit setting.

(3) Display the speed of the approaching vehicle if the speed is greater than 50% of the predetermined speed limit setting.

(D) The SFS assembly shall provide the functionality for the user to identify the GPS coordinates of the SFS assembly through the SWZ system software GUI. Changes in GPS coordinates of the SFS shall be logged in the SWZ system software with a timestamp.

(E) Each SFS assembly deployed within the SWZ area shall have a unique number to identify that location and differentiate it from other SFS locations.

710-2.08 GPS Location Sensor (GPSLS) Assembly:

Each GPSLS assembly shall be provided with all processing and disseminating equipment and functionality needed to determine the GPS location of the GPSLS and communicate that location to the SWZ system software. Each GPSLS assembly shall include all equipment necessary to provide a fully functional component of the SWZ system.

The GPSLS assemblies are intended to be standalone intelligent devices used to mark a specific location of interest within the work zone. The following are some examples for how the GPSLS assemblies are intended to be used:

(A) The SAB includes an auxiliary GPS location device that marks the beginning of a lane restriction within the work zone, but the SWZ system software and operator doesn't know where the end of the lane restriction is located, so a standalone GPSLS assembly is placed at the end of the lane restriction to inform the SWZ system software logic of where the lane restriction ends.

(B) In some work zones it may be desired to know where the Road Work Ahead, End of Work Zone, or other static construction signs are located, so a standalone GPSLS assembly will be placed at each of these static sign locations to inform the SWZ system software logic of where the work zone starts and ends.

Each GPSLS assembly shall be provided in accordance with the following:

(A) The GPSLS assembly shall provide the functionality for the user to identify the GPS coordinates of the GPSLS assembly

through the SWZ system software GUI. Changes in GPS coordinates of the GPSLS shall be logged in the SWZ system software with a timestamp.

(B) Each GPSLS assembly deployed within the SWZ area shall have a unique number to identify that location and differentiate it from other GPSLS assembly locations.

710-2.09 SWZ System Software:

The SWZ system software shall receive, store, analyze, and display real-time information from each TDC location, SWZ CMB assembly, VSLS assembly, traffic monitoring camera assembly, SAB assembly, SFS assembly, GPSLS assembly, and the associated auxiliary SWZ equipment deployed within the project SWZ area. The software shall provide the control logic, system configurations, automation, and commands for the SWZ CMB and VSLS display messages and speed limits.

The SWZ system software shall be furnished with all hardware, device drivers, and auxiliary SWZ equipment necessary to provide a fully functional component of the SWZ system that is accessed remotely by system operators, users, and Department representatives via the internet and by utilizing the software's client interface provided for use during the project.

The SWZ system software and services shall include setting limits and controls on the types of messages that can be displayed on SWZ CMB assemblies in accordance with Subsection 710-2.03 of the specifications.

The SWZ system software and services shall include an option to create a "Message Library" of project specific and Engineer approved messages that can be displayed on the SWZ CMBs within the SWZ area.

The SWZ system client interface shall:

Not have a limit to the number of Department representatives that can access the SWZ system software independently from different locations throughout the State of Arizona using an internet link and web browser. The SWZ system software shall be configured to limit the level of access granted to different users to help protect against accidental and malicious acts that can impact the integrity of system performance, configurations, CMB display messages, and posted VSLS speed limits.

Be a vendor hosted web site or software application(s) downloadable from one or more internet locations identified by the SWZ system software vendor(s).

Be accessible using personal computers (PC) running a Windows operating system and mobile devices running an Apple or Android operating system. The version of Windows used shall be compatible with the versions supported by the Engineer and TOC.

Include a GUI that displays the location of each TDC location, SWZ CMB assembly, VSLS assembly, traffic monitoring camera assembly, SAB assembly, SFS assembly, and GPSLS assembly deployed within the project SWZ area on a map and provides the associated unique numbers that identifies each location. The SWZ system software shall be configured to use the same unique numbers that have been imprinted on the actual devices in the SWZ area.

Provide the ability for Department representatives to see the current status of each TDC location, SWZ CMB assembly, VSLS assembly, and traffic monitoring camera assembly deployed within the project SWZ area, view all recorded data received from these field devices and the archived results of manual and system processed commands sent to field devices which display messages and speed limits to the traveling public.

The SWZ system software shall include a data exchange compliant with the WZDx Specification. The data exchange provided by the contractor shall update as the conditions of the work zone are changed, work zones are added, and work zones are removed through the SWZ system software.

The SWZ system software shall be comprised of the following subsystems integrated together as one complete system, as multiple separate software platforms, or any combination thereof, as required by the project plans and special provisions:

(A) Traffic Data Collection Subsystem (TDCS):

The TDCS shall be integrated with each TDC location deployed within the SWZ area to receive, archive, process, and disseminate the real-time traffic information for use by the other SWZ subsystems and by the Department for historical information, documentation, and future analyses.

The SWZ system GUI shall be configured to display each TDC location deployed within the SWZ area and the TDCS shall provide the following:

(1) Traffic volume counts for each direction of travel impacted by construction activities within every one-minute time interval for data archiving.

(2) Vehicle speeds for each direction of travel impacted by construction activities averaged together within a maximum time interval of one-minute for data archiving.

(3) The actual posted speed limit for each direction of travel impacted by construction activities and a speed limit compliance value based on the actual vehicle speed value compared to the posted speed limit value within every one-minute time interval for data archiving.

(4) Travel time between two points, one at near the beginning of the work zone and one at the end, averaged together within a maximum time interval of one-minute for data archiving for each direction of travel impacted by construction activities.

(5) Travel delay between two points, one at near the beginning of the work zone and one at the end, averaged together within a maximum time interval of one-minute for data archiving for each direction of travel impacted by construction activities. The travel delay values shall be based on the SWZ system generated real-time travel time data compared to a contractor provided "baseline set travel time data" that represents the typical travel time between the same two points, for each one-minute interval with each day of the week, when there was no construction or incident that would cause a travel delay.

(6) Queue lengths in locations when construction activities are causing or anticipated to cause traffic queuing for each direction of travel. The contractor proposed maximum time interval for data archiving and the methods used to determine queue lengths shall be approved by the Engineer prior to SWZ system deployment within the work zone.

(7) Traffic volume counts, vehicle speeds, speed limit compliance, travel time, travel delay, and queue length values based on longer time intervals, as selected by the Department representative through the SWZ system client interface, for generating the associated traffic information reports.

(8) Traffic volume counts, vehicle speeds, speed limit compliance, travel time, travel delay, and queue length values based on longer time intervals and associated alert message thresholds approved by the Engineer to send SWZ system generated alert messages to Department representatives via email or text messages.

(9) Crash occurrence data for each incident that occurred within the SWZ area based on the following data generated by the SWZ system or input into the SWZ system, by the contractor, using the SWZ system client interface:

(a) Geolocation coordinates of the crash

(b) Direction of travel the crash occurred in

(c) Approximate time the crash occurred

(d) Approximate time the crash was cleared from the travel lanes

(e) Approximate time the crash was cleared from the site

(f) Description of the crash

The TDCS shall be integrated with other required SWZ subsystems and receive, process, and disseminate additional types of the real-time traffic information that may be required by these other SWZ subsystems.

(B) Queue Warning Subsystems (QWS):

The QWS shall be integrated with the TDCS and the SWZ CMB assemblies to determine traffic queue lengths and warn approaching travelers of slowed or stopped traffic conditions.

The SWZ system GUI shall be configured to display each SWZ CMB assembly and TDC location associated with the QWS and the QWS component of the SWZ system and services shall provide the following:

(1) The ability to set and change real-time traffic information thresholds, within ranges approved by the Engineer, for the QWS automation logic that decides which queue warning message to display on each associated SWZ CMB location.

(2) The ability to set and change which messages from the "Message Library" can be used by the QWS for each of the different logic threshold scenarios.

(3) The ability to set a minimum time, within ranges approved by the Engineer, that a QWS generated message should be displayed on each SWZ CMB, before the QWS can change the message.

(4) When a queue begins to form, the QWS shall automate the process of displaying warning messages on the associated SWZ CMB assemblies located in advance of the anticipated queueing areas.

(5) The ability to send alert messages to Department representatives via email and text messages when the

QWS displays and removes warning messages on the associated SWZ CMB assemblies.

(6) The ability to send request messages to the Department's TOC operators via email and text messages asking them to consider displaying and removing queue warning related messages on specific FMS DMS locations in advance of the queueing area.

(C) Dynamic Lane Merge Subsystems (DLMS):

The DLMS shall be integrated with the TDCS and the SWZ CMB assemblies to determine traffic volumes and queueing conditions in advance of a lane or shoulder closure and instruct approaching travelers of when they should merge.

The SWZ system GUI shall be configured to display each SWZ CMB assembly and TDC locations associated with the DLMS. The DLMS components of the SWZ system and services shall provide the following:

(1) The ability to set and change real-time traffic information thresholds, within ranges approved by the Engineer, for the DLMS automation logic that decides which merge message to display on each associated SWZ CMB location.

(2) The ability to set and change which messages from the "Message Library" can be used by the DLMS for each of the different logic threshold scenarios.

(3) The ability to set a minimum time, within ranges approved by the Engineer, that a DLMS generated message should be displayed on each SWZ CMB, before the DLMS can change the message.

(4) When traffic volumes are high, or a potential queueing condition is detected by the DLMS, the DLMS shall automate the process of displaying pre-approved messages on the associated SWZ CMB assemblies that instruct drivers to merge later.

(5) When traffic volumes are low, and a potential queueing condition is not detected by the DLMS, the DLMS shall automate the process of displaying pre-approved messages on the associated SWZ CMB assemblies that instruct drivers to merge earlier.

(6) The ability to send alert email or text messages to Department representatives when the DLMS automatically changes messages on the associated SWZ CMB assemblies.

(7) The ability to send request messages to the Department's TOC operators via email or text messages asking them to consider adding or removing merge instructions displayed on specific FMS DMS locations in advance of the closure.

(D) Travel Time Subsystems (TTS):

The TTS shall be integrated with the TDCS and the SWZ CMB assemblies to determine real time travel times and travel delays between each associated SWZ CMB assembly and an Engineer approved end destination point within the SWZ area. The TTS shall also provide display messages on each respective SWZ CMB with the travel time and travel delay information.

The SWZ system GUI shall be configured to display each SWZ CMB assembly and TDC route associated with the TTS. The TTS component of the SWZ system and services shall provide the following:

(1) The ability to set and change real-time traffic information thresholds, within ranges approved by the Engineer, for the TTS automation logic that decides which travel time or travel delay message to display on each respective SWZ CMB.

(2) The ability to set and change which messages from the "Message Library" can be used by the TTS for each of the different logic threshold scenarios.

(3) The ability to set a minimum time, within ranges approved by the Engineer, that a TTS generated message should be displayed on each SWZ CMB, before the TTS can change the message.

(4) The ability to set the following types of Engineer approved rules for how the travel times and travel delay values will be displayed with the respective SWZ CMB display messages:

(a) Round the time value to the nearest multiple of five or ten, or round-up to the nearest multiple of five or ten.

(b) Display the time as greater than or less than a fixed time period when the real-time value exceeds or is below this value respectively.

(5) The ability to send alert email or text messages to Department representatives when the TTS displays a specific type of message on one of the respective SWZ

CMB, or if the travel times and travel delay values exceed a predetermined threshold.

(E) Traffic Monitoring Camera Subsystem (TMCS):

The TMCS shall be integrated with all the SWZ traffic monitoring camera assembly locations within the SWZ area and provide real-time viewing of the associated camera video streams for field personnel using mobile display devices and remotely by the Engineer, the TOC operators, and the District to monitor real-time roadway traffic conditions within the work zone.

The SWZ system GUI shall be configured to display the location of each SWZ traffic monitoring camera assembly and the TMCS component of the SWZ system and services shall provide the following:

(1) The ability to view the real-time video stream of SWZ traffic monitoring camera assembly location when selected from within the SWZ system GUI.

(2) Ability to adjust the field of view (i.e., pan, tilt, and zoom) of each SWZ traffic monitoring camera assembly.

(3) Ability to select between daytime and nighttime operations for each SWZ traffic monitoring camera assembly.

(4) Ability to adjust the iris and focus of each SWZ traffic monitoring camera assembly.

(5) Ability to set and select pre-set field of view positions of each SWZ traffic monitoring camera assembly, when PTZ cameras are deployed.

(F) Variable Speed Limit (VSL) Subsystem:

The VSL subsystem shall be integrated with the TDCS and the VSLS assemblies located in the SWZ area to reduce regulatory speed limits within the area(s) of the work zone that has the largest concentration of construction personnel exposed to the danger of an errant vehicle and raises the speed limit when construction workers are not present.

The configuration of the VSL subsystem shall include the unique number of a TDC location that is deployed near the center of the Active Work Space and this field device location shall be referred to as the Active Work Space TDC location. The VSL subsystem shall provide system automation logic that changes the posted speed limits based on the real-time traffic information it receives from the Active Work Space TDC location.

The VSL subsystem shall include a variable that represents the length of the Active Work Space and the ability to set a maximum value for this variable. This maximum value which represents the maximum allowable Active Work Space length shall be set to two miles, unless otherwise approved by the Engineer.

The SWZ system GUI shall be configured to display the Active Work Space TDC location, the length of the Active Work Space, the location of each SWZ VSLS deployed within the work zone, and the real-time speed limit posted on each SWZ VSLS. The VSL subsystem component of the SWZ system and services shall provide the following:

(1) The ability to only post speed limits in multiples of 5 mph on a VSLS.

(2) The ability to set a minimum and maximum speed limit value that can be posted on a VSLS for each direction of travel within the project limits.

(3) The ability to set a minimum time frame or minimum frequency between changes that a VSL subsystem generated speed limit should be displayed on each VSLS, before the VSL subsystem can change the speed limit.

(4) The ability to set a maximum value that can be used for lowering speed limits between any two consecutive VSLS locations within the same direction of travel.

(5) The intelligence needed to dynamically know which SWZ VSLS are in advance of the Active Work Space, within the Active Work Space, and subsequent to the Active Work Space, each time the contractor moves the Active Work Space TDC location within the project limits.

(6) The intelligence needed to dynamically lower the posted speed limits within the Active Work Space and on the VSLS directly in advance of the Active Work Space, while dynamically raising the speed limits on the other VSLS devices to the maximum allowable speed limit for the work zone.

(7) The ability to set and change VSL subsystem logic and Active Work Space TDC real-time traffic information thresholds, within ranges approved by the Engineer, for the VSL subsystem automation logic that decides which speed limits to post each respective SWZ CMB.

(8) The ability to dynamically raise the speed limits posted on all the VSLS to the maximum speed limit value or other user selectable lower value based on the time-of-

day and day-of-week scheduler and manual overrides to the schedule.

(9) The ability to only allow the speed limit message displayed on each VSLS to be in accordance with an R2-1 sign type, per the MUTCD, with white colored lighted pixels for displaying the speed limit message on a black background.

(10) The ability to send alert email and text messages to Department representatives when the speed limit messages on the associated VSLS contain a user selectable speed limit value.

(G) Truck Entry/Exit Subsystem (TEES):

The TEES shall be integrated with the TDCS and either a SWZ CMB assembly or a static sign with attached flashing warning lights and GPSLS assembly to determine when construction vehicles are entering the roadway from the work area and warn approaching travelers of slow-moving vehicles ahead.

The SWZ system GUI shall be configured to display each SWZ CMB assembly or static sign with attached flashing warning lights and GPSLS assembly and all TDC locations associated with the TEES. The TEES components of the SWZ system and services shall provide the following:

(1) When construction vehicles leave the work area and enter the roadway, the TEES shall automate the process of displaying either pre-approved messages on the associated SWZ CMB assemblies or illuminating the flashing warning lights on the associated static sign with GPSLS assembly that warn drivers of slow-moving vehicles ahead.

(2) The ability to set and change the time, within ranges approved by the Engineer, that a TEES generated warning should be displayed on either the associated SWZ CMB assembly or the associated static sign with attached warning lights and GPSLS assembly, before the TEES can change or remove the warning.

(3) The ability to send alert email or text messages to Department representatives when the TEES automatically changes messages on the associated SWZ CMB assemblies or illuminates the flashing warning lights on the associated static sign with GPSLS assembly.

710-2.10 Data Submittal:

The SWZ system software shall record all loss of communications, low power, and loss of power alerts for the project duration.

The SWZ system software vendor shall also record the following data before final project acceptance:

(1) All real-time traffic information received by the SWZ system software from all TDC locations deployed in the SWZ area and received by third-party sources, and all real-time traffic information generated by the SWZ system software within every one-minute time interval.

(2) All messages posted on all SWZ CMB assemblies deployed in the SWZ area.

(3) All speed limits on all VSLS assemblies deployed in the SWZ area.

(4) All geolocation data associated with these devices and the required device data.

(5) A date and time stamp that the data pertains to each data set.

This data shall be submitted electronically to the Engineer in a format compatible with the Work Zone Data Exchange Common Core Data Specification version available at the time of the project's bid opening date.

710-3 Construction Requirements:

The contractor shall coordinate with the Engineer and provide the SWZ software user training to the Department representatives. The contractor shall provide the Department representatives with SWZ software user access privileges including alert messages.

The SWZ system shall be deployed in accordance with the approved TCP, communications site assessment, system configuration plan, and subsystem acceptance testing procedures and provide the required certificate of analysis.

The contractor shall operate and maintain the SWZ system in accordance with the approved SWZ system O&M plan, relocate TDC locations, SWZ CMB assemblies, VSLS assemblies, traffic monitoring camera assemblies, SAB assemblies, SFS assemblies, and GPSLS assemblies and the associated auxiliary SWZ equipment deployed within the project SWZ area as necessary to achieve the SWZ system operational objectives. The required certificate of analysis shall be submitted to the Engineer each time one of the field device locations is moved.

During deployment in the SWZ area, the contractor shall submit the required SWZ system data reports to the Engineer for approval within the Engineer approval time frames.

Any deficiencies in the communications site assessment, SWZ system configuration plan, O&M plan, devices, equipment, services, or other elements of work listed herein will be brought to the attention of the contractor by the Engineer and all deficiencies shall be corrected before the close of that work shift, unless otherwise specified.

710-4 Method of Measurement:

SWZ system will be measured on a lump sum basis for a fully functional complete in place system.

TDC location, SWZ CMB assembly, traffic monitoring assembly, VSLS assembly, SAB assembly, SFS assembly, and GPSLS assembly will be measured by the day for each 24-hour day that the SWZ is in place and functional for the in-use condition, with no loss of communications or power failures for 98 percent of the calendar day or 98 percent of the portion of the calendar day that the system is in place.

Measurement for payment of the TDC location, SWZ CMB assembly, traffic monitoring assembly, VSLS assembly, SAB assembly, SFS assembly, and GPSLS assembly will begin on the day they are installed in place and fully functional. When the elements are not needed, they shall be removed or covered and will not be measured unless they are required to stay on site in anticipation of future use or emergency use as determined by the Engineer. Should devices be required on site for these purposes, they will be measured and paid for at the contract unit prices. During non-working periods such as holidays and weekends, the elements in place will be measured for payment. During these non-working periods the contractor shall conduct a minimum of one check per day to verify that the elements are in place and in satisfactory condition.

Elements of work which are lost, stolen, destroyed, or are deemed unacceptable by the Engineer, while in use on a project shall be replaced by the contractor at no additional cost to the Department.

710-5 Basis of Payment:

SWZ system, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place, as specified herein and shown on the plans, including all materials, equipment, and labor necessary to facilitate the SWZ system mobilization; obtain the Engineer's approval of required submittal documentation; provide SWZ system software, the SWZ client interface and user training, initial system configurations and associated acceptance testing, SWZ software user access privileges, alert messages, and SWZ system data reports; provide system and equipment

operations and maintenance, deployment location changes, and support services as needed to maintain a fully functional and operational SWZ system for the duration of the project; and removal of all SWZ equipment. Documentation of all lessons learned as a result of the SWZ installation, deployment, and removal shall also be included in the lump sum payment.

The accepted quantities of TDC locations, SWZ CMB assemblies, traffic monitoring camera assemblies, VSLS assemblies, SAB assemblies, SFS assemblies and GPSLS assemblies measured as provided above, will be paid for at the contract unit price each for the type of location or assembly designated in the bidding schedule, fully deployed and in operation in the SWZ area, which price shall be full compensation for the work described and specified herein and on the plans, and all other components necessary to provide a complete functional assembly for monitoring the SWZ area traffic conditions and controlling the SWZ operations.

Eighty percent of the contract lump sum price for the SWZ system will be paid upon satisfactory installation of a fully functional system, including its operation, maintenance, and ongoing service.

Twenty percent of the contract lump sum price for the SWZ system will be paid upon final removal.

Measurement and payment of static traffic control devices as shown on the TCP that are used in conjunction with the SWZ field equipment shall be paid for under their respective bid items.

No payment will be made for relocation of work elements and SWZ system configuration changes.

No payment will be made for setting up or relocating the necessary elements of work and associated protective devices that are moved concurrently with the advancing operation or removal at the end of a shift.

No payment will be made for the elements of work listed herein for non-working periods resulting from a suspension of work that, in the opinion of the Engineer, is due to the fault of the contractor. In any case, the contractor shall continue to be responsible for maintaining all SWZ system components in proper functioning condition at all times.

SECTION 711-729 BLANK:

SECTION 730 GENERAL REQUIREMENTS FOR TRAFFIC SIGNAL AND HIGHWAY LIGHTING SYSTEMS:

730-1 Description:

It is the purpose of this section to provide general information necessary for completion of the work on traffic signal and highway lighting systems in accordance with the details shown on the project plans and requirements of these specifications.

All electrical systems and appurtenances shall be complete, functional and in operating condition at the time of acceptance.

730-2 Definitions:

The words defined in the following subsection shall for the purpose of these specifications have the meanings ascribed to them pertaining to signals and lighting.

730-2.01 Actuation:

The operation of any type of controller initiated by a detector.

730-2.02 Back Plate:

A thin metal strip extending outward parallel to the signal face on all sides of a signal housing to provide suitable background for the signal indications.

730-2.03 Controller:

That part of the controller assembly which performs the basic timing and logic functions for the operation of the traffic signal.

730-2.04 Controller Assembly:

The complete assembly for controlling the operation of a traffic signal, consisting of a controller unit, and all auxiliary and external equipment housed in a weatherproof cabinet.

730-2.05 Cycle:

A complete sequence of signal indications.

730-2.06 Detector:

A device for indicating the passage or presence of vehicles or pedestrians.

(A) Inductive Loop Detector:

A detector capable of sensing the passage or presence of a vehicle by a change in the inductance characteristics of the wire loop.

(B) Magnetometer Vehicle Detector:

A detector capable of being actuated by the magnetic disturbance caused by the passage or presence of a vehicle.

(C) Pedestrian Detector:

A detector, for pedestrians, usually of the button type.

730-2.07 Flasher:

A device used to open and close signal circuits at a repetitive rate.

730-2.08 Flashing Feature:

This feature, when operated, discontinues normal signal operation and causes a predetermined combination of flashing signal lights.

730-2.09 Interval:

The part or parts of the signal cycle during which signal indications do not change.

730-2.10 Luminaire:

The assembly which houses the light source and controls the light emitted from the light source. Luminaires consist of a housing, lamp socket, reflector, and glass globe or refractor when specified.

730-2.11 Manual Operation:

The operation of a signal controller unit by means of a hand-operated switch.

730-2.12 Mounting Assembly:

The framework and hardware required to mount the signal face(s) and pedestrian signal(s) to the pole.

730-2.13 Pedestrian Signal:

A traffic control signal for the exclusive purpose of directing pedestrian traffic at signalized locations.

730-2.14 Pretimed Controller Assembly:

A controller assembly for operating traffic signals in accordance with a predetermined fixed-time cycle.

730-2.15 Red Clearance Interval:

A clearance interval which follows the yellow change interval during which both the terminating phase and the next right-of-way phase display red.

730-2.16 Signal Face:

An assembly controlling traffic in a single direction and consisting of one or more signal sections. Circular and arrow indications may be included in a signal assembly. The signal face assembly shall include the backplate and visors.

730-2.17 Signal Indication:

The illumination of a signal section or other device, or of a combination of sections or other devices at the same time.

730-2.18 Signal Section:

A complete unit for providing a signal indication consisting of a housing, lens, reflector, lamp receptacle and lamp.

730-2.19 Traffic Phase:

A part of the time cycle allotted to any traffic movement or combination of movements receiving the right-of-way during one or more intervals.

730-2.20 Traffic-Actuated Controller Assembly:

A controller assembly for operating traffic signals in accordance with the varying demands of traffic as registered with the controller unit by detectors.

730-2.21 Vehicle:

Any motor vehicle normally licensed for highway use.

730-2.22 Yellow Change Interval:

The first interval following the green right-of-way interval in which the signal indication for the phase is yellow.

730-3 Regulations and Codes:

All electrical equipment shall conform to the current standards of National Electrical Manufacturers Association (NEMA), National Electric Safety Code (NESC), Underwriters' Laboratory Inc. (UL), or the Electronic Industries Association (EIA), when applicable. All materials and workmanship shall conform to the requirements of the National Electric Code (NEC), Illumination Engineers Society (IES), the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the plans, these specifications, and the Special Provisions, and to any other codes, standards, or ordinances which may apply. Whenever reference is made to any of the standards mentioned, the reference shall be construed to mean the code, ordinance, or standard that is in effect at the time of the bid advertisement.

730-4 Equipment List and Drawings:

The contractor shall note that approval by the Engineer is required before ordering or installing any material that is to be used on the project.

The contractor shall submit a complete project material submittal for approval to the Engineer electronically by the pre-construction conference. In addition to the electronic submission, the Engineer may request up to three hard copies. The project material submittal shall state all relevant information regarding materials and equipment to allow the Department to procure exact replacements of any or all items on the project. To be acceptable, the material submittal shall be complete and contain all items supplied on the project by the contractor. The Department reserves the right to reject an incomplete or unclear material submittal.

The materials on the submittal shall be identified by the contract project number, bid item numbers, catalog part numbers, catalog cuts, shop drawings for signal and lighting equipment, trade names, schedules for other pertinent information. The materials from any catalog cuts shall be clearly indicated by the contractor. Any material designations used in the contract documents shall be so noted on the materials list. If requested by the Engineer, the contractor shall submit manufacturer shop drawings for review and approval and shall furnish Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications.

There shall be no substitutions for any of the materials on the list without prior written approval by the Engineer. Changes to the approved materials list shall be submitted in writing to the Engineer. If requested by the Engineer, the contractor shall submit samples of the proposed materials for inspections, testing, and approval by the Department. The Department will not be liable for any electrical materials procured or any labor performed prior to approval.

When the plans include lighting, the contractor shall submit photometric data sheets indicating the IES distribution classification for each type of luminaire submitted for approval to the Engineer electronically. In addition to the electronic submission, the Engineer may request up to three hard copies. In addition, the contractor shall submit data from the manufacturer detailing lamp socket positions in relation to lamps and optical systems furnished for each IES distribution type specified. If required by the Special Provisions, the contractor shall provide computer printout grids of both luminance and illuminance values for the spacing, height, roadway width, and type of luminaire submitted.

The contractor shall provide complete wiring diagrams for controller assemblies and auxiliary controller cabinets at the time of delivery for testing. A mylar original and four sets of prints shall be provided with each controller assembly. The wiring diagram shall illustrate all circuits and components in detail. All components shall be identified by name or number so as to be clearly noted in the drawings.

730-5 Warranties & Guaranties:

Manufacturer's warranties and guaranties, furnished for materials and equipment used in the work, shall be delivered to the Engineer prior to acceptance of the project. Warranties and guaranties shall conform to the requirements of Subsection 106.13 of the specifications.

730-6 Locations of Utilities:

The locations of utilities shown on the project plans are approximate. All involved utilities may not be shown on the plans.

In addition to the requirements of Subsection 107.15 of the specifications, the contractor's attention is directed to the requirements of A.R.S. 40-360.21 through .29 requiring all parties excavating in public streets, alleys or utility easements to first secure the locations of all underground facilities in the vicinity of the excavation.

The contractor shall contact the Blue Stake Center at least two working days prior to commencing excavation, for information relative to the location of buried utilities within the project limits.

730-7 Installation of Decals:

The contractor shall furnish and install a maintenance unit number decal approximately 42 inches above the base-plate displayed on the traffic-side of the device at a 45 degree angle to the direction of travel, or as approved by the Engineer. The device shall not be adjusted to make them 45 degrees. Each electrical cabinet and lighting pole, or other items as specified on the plans or as directed by the Engineer, shall receive a feature number decal. Feature number to be installed on each specific electrical device shall be as shown on the pole schedule in the plans.

Maintenance unit number decals shall be approximately 2 inches in width with digits approximately 3 inches in height and in Serif-style font, unless shown in the plans or specified otherwise. The decal digits shall be stacked vertically from top to bottom. The decal shall be Type III reflective sheeting. The color for the digits shall be black on white background. A decal sample shall be provided to the Engineer for approval prior to system acceptance testing.

The contractor shall not install a decal until the electrical device has been installed in its final configuration and inspected and accepted by the Engineer.

No measurement or payment will be made for furnishing or installation of the decals, the cost being considered as included in the price of the contract items.

SECTION 731 STRUCTURAL SUPPORTS AND FOUNDATIONS FOR TRAFFIC SIGNAL AND HIGHWAY LIGHTING:

731-1 Description:

The work under this section shall consist of furnishing all materials and constructing new supports and foundations for traffic signal and highway lighting systems or modifying poles and mast arms of existing systems at the locations shown on the plans and in accordance with the details shown on the plans and the requirements of these specifications.

Pole foundations shall include all conduits, elbows, anchor bolts, grounding wires and reinforcing steel. Cabinet foundations shall include conduits, elbows, anchor bolts and clearance pads.

731-2 Materials:

Excavation and backfill shall conform to the requirements of Subsection 203-5.03 of the specifications. Concrete shall conform to the requirements of Sections 601 and 1006 of the specifications. Reinforcing steel and wire mesh shall conform to the requirements of Sections 605 and 1003 of the specifications.

Concrete for all foundations shall be Class S and shall have a required 28-day compressive strength of 3,500 pounds per square inch.

731-2.01 Aluminum Poles and Mast Arms:

(A) General:

Standard aluminum poles assemblies for highway lighting shall include pole shafts, pole bases, and mast arms. Aluminum components of the

pole, mast arm, base, and hardware shall conform to the details shown on the plans and in these specifications.

Each aluminum pole and mast arm shall be designed and manufactured as a complete assembly. The assembly shall be furnished and installed as a complete unit that is configured to the necessary dimensions with all the required components including mounting brackets and assembly, ground lugs, rain caps, hand hole covers, anchor bolts, nuts, washers and related hardware and accessories.

The design of the pole assembly (pole, mast arm, and luminaire attachment portion) shall be per the requirements of the 2013 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 6th edition with 2015 interim revisions. The design of the poles, mast arms and luminaire mounting brackets shall be based on a wind speed of 90 miles per hour with a luminaire having an effective projected area of 1.5 square feet and a weight of 55 pounds.

The design shall also be based upon the worst case loading, derived by combining the loads caused by a 20 foot truss mast arm, except for S and T poles, design luminaire, design wind speed and other dead loads, as appropriate. Secondary deflections shall be accounted for in all designs.

Aluminum poles shall have a minimum design life of 50 years.

The pole and mast arm shall be supplied from the same manufacturer and of similar metal properties providing a uniform appearance.

(B) Pole and Mast Arm Assembly Design Parameters:

(1) Pole Shafts:

The tapered pole shaft shall be fabricated from a one-piece, seamless, round tapered tube of Aluminum Alloy 6063-T6, conforming to the requirements of ASTM B221, and shall be full-length heat treated after tapering and welding on the base and hand hole reinforcing to produce a T6 temper. The pole shafts shall either maintain a uniform taper rate from the base of the pole to the pole top or shall be non-tapered. The base plate shall be constructed to match the foundation bolt pattern for standard poles shown in the Standard Drawings for Aluminum Light Poles. No field splices of pole shafts shall be allowed. The pole shaft shall have an internal vibration damper.

The pole shaft shall be smooth with a uniform brushed sheen finish that is free from all dents, scratches, and shipping/handling marks. Poles that have a finish that is not uniform or that fails to meet the requirements of this specification will be rejected by the Engineer and shall be repaired or replaced to the satisfaction of the Engineer at no

expense to the Department in accordance with Subsection 105 of the specifications.

All aluminum poles shall have a hand hole in the base of the poles and shall conform to the details shown on the Standard Drawings, with the exception that the hand hole shall use aluminum components and stainless steel screws.

An aluminum tag shall be permanently attached to the pole above the hand hole. The tag shall state the manufacturer's name, pole type, ADOT standard drawing number, pole length, and gage number.

(2) Truss Mast Arms:

The aluminum truss mast arms shall be fabricated by the same manufacturer as the aluminum pole manufacturer and from Aluminum Alloy 6063-T6 conforming to the requirements of ASTM B221.

The aluminum truss mast arms shall be smooth with a uniform brushed sheen finish that is free from all dents, scratches, and shipping/handling marks. Aluminum truss mast arms that have a finish that is not uniform or that fails to meet the requirements of this specification will be rejected by the Engineer and shall be repaired or replaced by the contractor to the satisfaction of the Engineer at no expense to the Department in accordance with Subsection 105 of the specifications.

(3) Welding:

Welding of all components of aluminum light poles shall conform to the American Welding Society (AWS) D1.2 Specifications for Class I Structures. All aluminum components and welding shall be identified and included in the Certificate of Analysis, which shall state compliance to AWS Specifications.

(4) Break-away Transformer Bases:

Break-away bases for light poles and flasher poles shall be a frangible pole mounting pedestal (base). Break-away bases shall be used on Type A, G, H, I, S, and T poles when indicated on the plans or specifications. Break-away bases shall be fabricated from 356 T6 aluminum alloys and shall have a stainless steel wheel abraded finish. The break-away bases shall have all the necessary hardware to make a complete and functional unit.

Bolts, nuts, and washers connecting the pole to the break-away base shall be fabricated from steel conforming to the requirements of ASTM F3125 Grade A325. Bolts shall be galvanized in accordance with the requirements of ASTM F2329. The 2-3/4 inch x 1/2-inch thick washers shall be zinc mechanically coated per ASTM B695-85 Class 50 or shall be galvanized per the requirements of ASTM F2329.

Welding of all components of aluminum break-away bases shall conform to the AWS D1.2 Specifications

Break-away bases shall be certified by the manufacturer to meet or exceed the change in momentum requirements of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, and to be acceptable for use on Federal Aid projects. The manufacturer shall also certify that the break-away base has been tested and approved by the Federal Highway Administration (FHWA) and that the casting has the same chemistry, mechanical properties, and geometry as the casting used in the tests.

(5) Anchor Bolts, Nuts, and Washers

All anchor bolts shall be fabricated from steel conforming to the requirements of ASTM F1554 Grade 55, shall be fully galvanized in accordance with the requirements of ASTM F2329, and shall conform to the requirements shown on the Standard Drawings. All anchor bolts shall be submitted for approval and a certificate of analysis shall be provided from the manufacturer that is in accordance with the requirements of Subsection 106.05 of the specifications.

(C) Submittals:

The contractor shall submit a Certificate of Analysis for all aluminum components in accordance with the requirements of Section 106.05 of the specifications. The contractor shall also submit shop drawings that have been sealed and signed by a registered professional engineer that show all the details of the poles assembly units to be furnished and installed. The shop drawings shall be complete in every aspect, including all dimensions, material specifications and appropriate details. The details shall include the configuration of the pole shaft, mast arm and mast arm mounting bracket, base plates, luminaire mounting bracket and the hand hole. All welds shall be shown and identified with standard AWS symbols. The submittal shall include structural calculations along with the name of the engineer(s) who sealed the drawings and performed the calculations.

The contractor shall submit the supporting documents for review by the Engineer. The principal purpose of the review is to verify that suitable structural calculations have been made in the design of the pole and mast arm assembly. The contractor's engineer shall utilize accepted standard engineering principles. If a computer program is utilized, the contractor shall furnish the Engineer with all necessary information, such as formulas and assumptions, to conduct a meaningful review.

The Engineer shall provide written review comments to the contractor. The contractor shall respond to these comments and resubmit the calculations, if required. Fabrication shall not take place until the shop drawings have been approved.

If the contractor utilizes a pre-approved design from ADOT's Approved Product List (APL), submittal of the structural calculations is not required. Shop drawings for APL designs shall be submitted. Drawing numbers for the pre-approved designs found in the APL are available at https://azdot.gov/business/engineering-and-construction/product-evaluation-program.

731-2.02 Steel Poles and Mast Arms:

(A) General:

Standard steel poles assemblies for traffic signals and highway lighting shall include pole shafts, mast arms, and pole bases. Steel components of the pole, mast arm, base, and hardware shall conform to the details shown on the plans and in these specifications.

Each steel pole and mast arm shall be designed and manufactured as a complete assembly. The assembly shall be furnished and installed as a complete unit that is configured to the necessary dimensions with all the required components including mounting brackets and assembly, ground lugs, rain caps, hand hole covers, anchor bolts, nuts, washers and related hardware and accessories.

The design of the traffic signal and lighting supports shall be per the requirements of the 2013 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 6th edition, with the 2015 interim revisions.

All pole lighting supports and mast arms shall be designed to withstand 90 miles per hour wind, and a 3-second Gust. Fatigue analysis is to be per Fatigue Category 2, without galloping. Truck Induced velocity shall be 55 mph wind speed.

Metal parts of standard steel poles and hardware shall conform to the details shown on the plans and the following specifications. Welding shall conform to the requirements of the American Welding Society, Structural Welding Code - Steel, D1.1, latest edition.

(B) Pole and Mast Arm Assembly Design Parameters:

(1) Poles Shafts:

Tapered pole shafts shall be fabricated from sheet steel of weldable grade which shall meet a minimum yield stress, after fabrication, of 50,000 pounds per square inch. A taper rate of approximately 0.14 inches in diameter per linear foot shall be required unless otherwise specified.

Standard pipe pole shafts shall be fabricated from standard weight structural steel which conforms to the minimum strength requirements of ASTM A53, or A500 Grade B. Each section shall be fabricated from not more than two pieces of sheet steel. When two pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded, seams shall be directly opposite to one another. When the sections are butt-welded together, the longitudinal welded seams on adjacent sections shall be placed to form continuous straight seams from base to top of pole. Pole shafts shall be straight, with a permissive variation not to exceed one inch measured at the midpoint.

Pole shafts shall be galvanized in accordance with the requirements of ASTM A123. The visual appearance of the galvanized finish shall be uniform. Discoloration of the galvanized finish such as dark areas, dark streaks, dark rings or transportation handling marks which are considered excessive by the Engineer shall not be allowed. Pole shafts that have a finish unacceptable to the Engineer shall either be repaired or replaced to the satisfaction of the Engineer at no additional cost to the Department.

Hand holes in the base of the poles shall conform to the details shown on the Standard Drawings. All welds shall be continuous and any exposed welds, except fillet welds, shall be ground flush with the base metal.

A metal tag shall be permanently attached to the pole above the hand hole stating the manufacturer's name, pole type per the Department's plans, pole drawing number, shaft length and gage number.

(2) Mast Arms:

Tapered mast arms for all pole types shall be fabricated from sheet steel with a minimum yield stress of 50,000 pounds per square inch after fabrication. Mast arms shall be fabricated according to the thickness requirements shown on the plans.

A taper rate of approximately 0.14 inches change in diameter per linear foot shall be required unless otherwise specified. All bolts, washers, and nuts for mast arms shall be high strength, shall be fabricated from steel which meets the requirements of ASTM F3125 GR A325, and shall be electro galvanized in accordance with the requirements of ASTM F2329.

Mast arms shall be galvanized in accordance with the requirements of ASTM A123. The visual appearance of the galvanized finish shall be uniform. Discoloration of the galvanized finish such as dark areas, dark streaks, dark rings or transportation handling marks which are considered excessive by the Engineer shall not be allowed. Mast arms that have a finish unacceptable to the Engineer shall either be repaired or replaced to the satisfaction of the Engineer at no additional cost to the Department.

A metal tag shall be permanently attached on the side of the mast arm near the base stating the manufacturer's name, pole type and name as shown on the plans, mast arm or pole drawing number, length, and gage number.

(3) Steel Pole Extensions and Twin Luminaire Brackets:

Pole extensions and twin luminaire brackets shall be fabricated from new pipe conforming to the requirements of ASTM A53 or A500 Grade B. All welding shall conform to the requirements of the American Welding Society, Structural Welding Code - Steel, D1.1, latest edition. Pole extensions and twin luminaire brackets shall be fully galvanized in accordance with the requirements of ASTM A123. Fabrication of the pole extensions and twin luminaire brackets shall be in accordance with the dimensions as specified in the plans.

(4) Standard Bases:

Poles shall have standard bases fabricated from structural steel plates conforming to the minimum strength requirements of ASTM A36. Exposed surfaces shall be finished smooth and all exposed edges shall be neatly rounded to a 1/8-inch radius. Standard bases shall be galvanized in accordance with the requirements of ASTM A123.

(5) Anchor Bolts, Nuts and Washers:

Standard anchor bolts, washers, and nuts shall be fabricated from steel conforming to the strength requirements of ASTM F1554 Grade 55. Anchor bolts, washers, and nuts shall be fully galvanized in accordance with the requirements of ASTM F2329. Anchor bolts shall conform to the requirements shown on Standard Drawings.

Welding shall not be performed on any portion of the body of these bolts. Certificates of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for high strength bolts, washers and nuts.

(C) Submittals:

The contractor shall submit a Certificate of Analysis for all steel components and welding in accordance with the requirements of Section 106.05 of the specifications. The contractor shall also submit shop drawings that have been sealed and signed by a registered professional engineer that show all the details of the poles assembly units to be furnished and installed. The shop drawings shall be complete in every aspect, including all dimensions, material specifications and appropriate details. The details shall include the configuration of the pole shaft, mast arm and mast arm mounting bracket, base plates, luminaire mounting bracket and the hand hole. All welds shall be shown and identified with standard AWS symbols. The submittal shall include structural

calculations along with the name of the engineer(s) who sealed the drawings and performed the calculations.

The contractor shall submit the supporting documents for review by the Engineer. The principal purpose of the review is to verify that suitable structural calculations have been made in the design of the pole and mast arm assembly. The contractor's engineer shall utilize accepted standard engineering principles. If a computer program is utilized, the contractor shall furnish the Engineer with all necessary information, such as formulas and assumptions, to conduct a meaningful review.

The Engineer shall provide written review comments to the contractor. The contractor shall respond to these comments and resubmit the calculations, if required. Fabrication shall not take place until the shop drawings have been approved.

If the contractor utilizes a pre-approved design from ADOT's Approved Product List (APL), submittal of the structural calculations is not required. Shop drawings for APL designs shall be submitted. Drawing numbers for the pre-approved designs found in the APL are available at https://azdot.gov/business/engineering-and-construction/product-evaluation-program.

731-2.03 Wood Poles:

(A) General:

Wood poles shall consist of full length, pressure treated material. Unless specified herein, material, treatment, and preservatives shall be in accordance with the latest revisions of the AWPA Book of Standards.

No deviations from these specifications will be allowed without the written approval of the Engineer.

Wood poles shall be used for service or temporary traffic signal or roadway lighting installations when specified. The lengths of the poles shall be 25 feet for service poles and 35 feet for other poles and shall be Class 3, unless otherwise specified.

(B) Definitions:

AWPA:

As defined in Subsection 101.01 of the specifications.

Supplier:

The person, partnership, association, or corporation furnishing the material covered by these specifications.

Check:

A separation of the wood along the grain, the greater part of which occurs across the annual growth rings. A through check extends from surface to surface of the pole, usually through the pith center.

Compression Wood:

Abnormal wood that often forms on the lower side of branches and inclined trunks of coniferous trees. Characteristics include:

(1) Relatively wide annual ring, usually eccentric;

(2) Relatively high proportion of summerwood (frequently more than 50 percent of the width of the annual ring in which it occurs);

(3) Exhibits very little contrast in color between springwood and summerwood; and

(4) Shrinks excessively lengthwise as compared with normal wood.

Cross-Break (Crack):

A separation of the wood cells across the grain. Such breaks may be due to internal strains resulting from unequal longitudinal shrinkage or to external force.

Dead Knot:

A knot left by a branch that dies before the tree is cut. An encased knot is a dead knot in which the growth layers are not intergrown with those of the surrounding wood. Dead knots may contain soft fibers (decay) that usually do not extend deeper than 1 to 2 inches from the pole surface. They are distinct from rotten or decayed knots in which the loose or soft fibers (decay) may extend the full length of the knot into the pole, and which are frequently associated with heart rot.

Dead Streak:

Any portion of sapwood in which the life processes had ended prior to the cutting of the tree. A dead streak starts from the butt and differs from a wound, such as a catface or scar, where the growth of new wood shows that life processes are still acting to repair the injured part.

Decay:

Decay or rot (advanced decay) is the disintegration of wood substance due to the action of wood destroying fungi.

Face of Pole:

The concave side, or the side of greatest curvature in poles having reverse or double sweep, between the ground line and top of pole.

Ground Line Section:

That portion of a pole between 1 foot above and 2 feet below the ground line as defined in the pole dimension tables.

Hollow Heart:

A hollow in the heartwood of a living tree caused by insects or fungi.

Hollow Pith Center:

A small hole at the pith center of the trunk or of a knot, caused by disintegration of the pith (small soft core occurring in the structural center of a tree or branch).

Insect Damage:

The result of boring in the pole by insects or insect larvae. Scoring or channeling of the pole surface is not classed as insect damage.

Knot Diameter:

The diameter of a knot on the surface of the pole measured in a direction at right angles to the lengthwise axis of the pole.

Red Heart:

A fungus caused by Fomes Pini occurs in the living tree, and is characterized in the early stages of infection by a reddish or brownish color in the heartwood. This is known as "firm red heart". Later, the wood, in the case of the living tree, disintegrates (decays) in small, usually distinct, areas that develop into white-line pockets.

Sap Satin:

A discoloration of the sapwood caused by the action of certain molds and fungi that is not accompanied by softening or other disintegration of the wood. Refer to Subsection 731-2.03(D)(2)(a) of the specifications for blue stain.

Scar (Catface):

A depression in the surface of the pole resulting from a wound where healing has not re-established the normal cross section of the pole.

Shake:

A separation along the grain, the greater part of which occurs between the rings of annual growth.

Short Crook:

Any localized deviation from straightness, in a 5-foot section or less, shall be classified as a short crook.

Spiral Grain (Twist Grain):

A type of growth in which the fibers take a spiral course around the bole of a tree instead of the normal vertical course. The spiral may extend right-handed or left-handed around the tree trunk. The amount of spiral grain in a pole is measured as the distance in feet, along the axis of the pole, in which one complete twist of the spiral occurs, and is expressed as a ratio; for example, "1 in 30" (one twist in 30 feet).

Split:

A lengthwise separation of the wood due to the tearing apart of the wood cells, extending from surface to surface of the pole.

Sweep:

The deviation of a pole from straightness.

(C) Acceptance Species:

(1) Douglas Fir (Pseudotsuga menziesii, MIRB. Franco):

(2) Southern Pines:

(3) Western Pine:

(a) Loblolly (Pinus taeda)

(b) Longleaf (Pinus palustris)

(c) Pond (Pinus rigida serotina)

(d) Shortleaf (Pinus echinata)

(e) Slash (Pinus caribaea)

(f) Ponderosa (Pinus ponderosa laws)

(D) Defects:

(1) Prohibited Defects:

Pole exhibiting any of the following defects will not be accepted:

Bird Holes;
Breaks;
Catface (Scars);
Compound through checks;
Decay;
Double Sweep (poles having sweep in two planes);
Hollow butts or tops;
Improper Framing;
Nails or other metal not authorized by the Engineer;
Plugged holes (other than increment borer);
Small Butt;
Small Top;
Spike knots or any knot with bark inclusion;
Split top; and/or
Worm or insect holes

(2) Limited Defects:

The following defects are acceptable subject to the limitations stated:

(a) Blue Stain:

The core used to check penetration of preservative will be checked for blue stain. Any core with 50 percent or more blue stain in sapwood will be rejected. Additional cores may be taken to determine extent of the stain.

(b) Check:

Any check more than 1/8 inch wide and extending down from the top of the pole more than 12 inches and within 30 angular degrees from the axis of the face of the pole directly above the brand will be unacceptable.

Through checks or splits in the butt surface are permitted, provided their height from the butt along the side surface does not exceed 2 feet.

A check is considered to be continuous if it is not separated by at least 1/2 inch of wood. Maximum acceptable dimensions of checks are as follows:

Length of Pole	Maximum Width	Maximum Length
30 feet and shorter	1/4 inch	5 feet
35 and 40 feet	5/16 inch	5 feet
45 feet and longer	3/8 inch	8 feet

(c) Compression Wood:

Compression wood in the outer 1-1/2 inch of pole.

(d) Insect damage:

Insect damage consisting of surface scoring or channeling are permitted; all other forms of insect damage are prohibited.

(e) Insufficient Sapwood:

Sapwood thickness less than the following:

Douglas Fir	1 inch
Pine	3 inches

(f) Knot:

The following criteria applies:

All knots shall be measured at right angles to lengthwise surface, including the sapwood as well as the heartwood portions. All end grained, completely concentric annual rings surrounding the prominent heartwood portion of the knot shall be included in the measurement.

The diameter of any single knot or the sum of the diameters of all knots in any 1-foot section shall not exceed the limits set up in the following table. Knots 1/2 inch or less in diameter shall be ignored in applying the limitations for the sum of diameters.

Length/Class of Pole	Diameter of Any Single Knot	Sum of Diameters of Knots in Any 1-Foot Section
45 feet and shorter	2.5 inches	8 inches
50 feet and longer	3.0 inches	10 inches

Maximum single knot in any sworl shall be 2 inches in diameter.

Maximum sum of knots in any sworl shall not exceed 20 percent of the pole circumference at the point of the sworl or more than the amount shown in the table above under the column heading "Sum of Diameters of Knots in Any 1-Foot Section."

(g) Mechanical Damage:

Poles are not acceptable if they have abrasions or damage caused by forklifts, dragging along the ground, indentation of chains, cables, cant hooks, peaveys, pole tongs, or other mechanical damage penetrating the pole more than 3/4 inch.

(h) Pilodyn:

The pilodyn can be used to check hardness of poles. The test will normally be taken at the ground line and any measurement 22 millimeters and over on ponderosa pine will result in that pole being rejected. Additional tests may be taken at any point on the pole to determine extent of softness.

(i) Ring Count:

The average annual ring count shall be not less than six rings per inch average measured in the outer 3 inches on the butt face.

(j) Sapstain:

Stain that is not accompanied by softening or other disintegration (decay) of the wood is permitted.

(k) Shake:

Shakes in the butt surface extending through an arc of not more than 90 degrees are permitted, provided they are at least 2 inches from the outside diameter of butt.

(l) Short Crook:

Any localized deviation from straightness in a 5-foot section or less shall be classified as a short crook, and the deviation from straightness shall not exceed 1-1/2 inches.

(m) Spiral Grain:

Spiral grain is permitted provided it does not exceed 1/2 turn in 15 feet or one complete turn in any 30 feet of the pole.

(n) Sweep:

Where sweep is in one plane and one direction only, a straight line connecting the surface of the pole at a point located 6 feet from the butt, and the edge of the pole at the top shall not be separated from the surface of the pole at any point by more than 1 inch for each 10 feet of length between these points.

Where sweep is in one plane and two directions (reverse sweep), a straight line connecting the midpoint at a point located 6 feet from the butt with the midpoint of the top shall not deviate from the center line of the pole more than 1/4 the diameter of the pole at the point of widest deviation.

(E) Dimensions:

(1) Length:

Poles less than 50 feet in length shall be not more than 3 inches shorter or 6 inches longer than nominal length.

Poles 50 feet or more in length shall be not more than 6 inches shorter or 12 inches longer than nominal length.

The minimum lengths for the wood species shown are as follows:

Wood Species	Minimum Length of Pole
Douglas Fir	50 feet
Western Pine	45 feet
Southern Pine	30 feet

(2) Classification:

The pole circumference at the top and at a point 6 feet from the butt shall not be less than the dimensions shown below:

Pole Dimensions, Class 3			
Minimum Circumference at Top is 23 inches		Minimum Circumference at 6 Feet from Butt (Inches)	
Length of Pole (Feet)	Groundline Distance from Butt (Feet)	Western Pine	Douglas Fir and Southern Pine (all types)
20	4	29.5	27.0
25	5	32.5	29.5
30	5.5	35.0	32.0
35	6	37.5	34.0
40	6	39.5	36.0
45	6.5	41.5	37.5
50	7	43.5	39.0
55	7.5	45.0	40.5
60	8	46.5	42.0

(F) Manufacturing Requirements:

(1) Bark Removal:

Poles shall be smoothly trimmed by machine; the depth of the cut shall be kept to a minimum consistent with proper removal of the bark. Beveling the top or butt, excessive trimming around knots which results in separation in wood structure (knot pop-up), prominent spiral ridges

on pole surfaces, rough or feathery surfaces, exposed heartwood (except at knot areas), patches of inner bark more than 1/2 inch wide and 6 inches long, and abrupt changes in contour due to shaving are evidences of improper removal of bark. Individual poles with such defects shall be rejected.

(2) Marking:

The following marks shall be burn-branded legibly on the butt and on the face of the pole per AWPA Standard M6 at a point 12 feet ± 2 inches tolerance:

(a) The supplier's code or trademark;

(b) The Plant location and the year of treatment;

(c) Code letters denoting pole species and preservative used; and

(d) The circumference class numeral and numerals showing the length of the pole.

(3) Treating Charge Number:

Code numerals indicating the treating charge number must be placed on the butt either by stamping or on metal tags.

(G) Preservatives:

(1) Preservative Requirements:

The type of preservative to be used shall be Penta-Volatile Petroleum Solvent (Cellon or Dow process).

(2) Penta-Volatile Petroleum Solvent:

The pentachlorophenol shall conform to AWPA Standard P8. The carriers shall be hydrocarbon solvents Type B or D conforming to AWPA Standard P9.

(H) Treatment:

(1) Poles:

Poles shall be treated in accordance to AWPA Standards C1 and C4.

(2) Moisture Content:

Prior to treatment, poles shall be sufficiently air-seasoned, boultonized or kiln-dried to minimize checking after treatment and to permit maximum penetration and retention of preservative. Moisture content of the sapwood shall be below 25 percent. The moisture content may be determined by electrical resistance type moisture meters and shall have insulated needles driven 2 inches in fir or 2-1/2 inches in pine.

(3) Retention:

Douglas Fir - The treating process must produce not less than 1 inch penetration at any point on the pole. If the sapwood thickness exceeds 1 inch between the butt and standard ground line, 85 percent of the sapwood shall be treated. The assay zone shall be 1/4 to 1 inch.

Cellon or Dow Process - Retention shall be not less than 0.90 pounds per cubic foot in the assay zone.

Western and Southern Pines - The treating process must produce complete sapwood penetration. The assay zone shall be 0.5 to 2.0 inches.

Cellon or Dow Process - Retention shall be not less than 0.60 pounds per cubic foot in the assay zone.

(4) Penetration:

Not less than one increment core shall be taken in the ground line area. All increment borer holes shall be plugged with tight fitting cylindrical wood plugs treated with the same preservative used to treat the pole. Penetration shall be determined by the following methods.

Cellon or Dow Process - Penta Check or Wetzel Stain.

(5) Cleanliness - After Treatment:

Cellon or Dow Process - Poles shall be washed or brushed so they are clean and free of surface crystals.

(6) Retreatment:

All poles which fail to meet the treating requirements of this specification may be treated one time after initial inspection. Temperature and pressure must conform to AWPA Standard C1 for retreatment.

Stored Poles - All poles showing brands or marks indicating treatment within any calendar year three years or more previous to the year of shipment shall be retreated one time conforming to AWPA Standard C1.

Cut Back Poles - All poles that are shortened or trimmed shall be retreated within seven days conforming to AWPA Standard C1.

(l) Inspection:

Inspection shall be made upon delivery. The Contractor shall provide the necessary assistance and facilities to enable safe and efficient inspection of the work. A Certificate of Compliance shall be furnished to the Engineer upon delivery to the job site or other approved locations.

731-3 Construction Requirements:

731-3.01 Shop Drawings:

The contractor shall furnish shop drawings for approval by the Engineer prior to fabrication of the traffic signals and highway lighting structures material. Shop drawings shall be prepared in accordance with the requirements of Subsection 105.03 of the specifications.

731-3.02 Foundations:

The excavations required for the installation of foundations and other items shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping, and other improvements. The trenches shall not be excavated wider than necessary for the proper construction of the foundations and other equipment. Excavation shall not be performed until immediately before construction of foundations. The material from the excavation shall be placed in a position that will minimize obstructions to traffic and interference with surface drainage.

All surplus excavated material shall be removed and properly disposed of within 48 hours by the contractor, as directed by the Engineer. After each excavation is completed, the contractor shall notify the Engineer for inspection, and under no circumstances shall any underground materials or equipment be covered with fill without the approval of the Engineer.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of the specifications. At the end of each working period, all excavations shall be barricaded or covered, or both, to provide safe passage for pedestrian and vehicular traffic.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted at any time, unless otherwise provided in the Special Provisions.

Sidewalk and pavement excavations shall be kept well covered and protected to provide safe passage for pedestrian and vehicular traffic until permanent repairs are made.

Signal and lighting pole foundations shall be set flush with the existing or new curb and sidewalk or flush with the finished grade where there is no curb or sidewalk, except in sloped areas they shall be as shown on the plans. The dimensions and locations of foundations shall be as specified on the plans; however, the Engineer may direct that changes be made in locations due to obstructions or other existing conditions. The contractor shall verify top of foundation elevations with the Engineer prior to foundation construction.

Concrete shall be placed in holes which have been augered against undisturbed earth. If the material in the bottom of the hole is not firm and stable, it shall be compacted or treated as directed by the Engineer. The walls and the bottoms of the holes shall be thoroughly moistened prior to placing the concrete.

If the soil is not stable and a hole cannot be augered, forms shall be used. They shall be of the proper size and dimensions and shall be rigid and securely braced. The forms and the bottoms of the holes shall be thoroughly moistened prior to placing the concrete.

If the Engineer requires foundations to be larger or deeper than on the plans because of soil conditions, the additional work will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

Anchor bolts and conduit stubs shall be placed and held in proper alignment, position, and height during the placing and vibrating of concrete. All pole foundations shall set for seven days prior to pole installation.

Before the concrete for cabinet foundations has set, depressions shall be made around the anchor bolts for adjustment of the cabinet leveling nuts.

The stations and offsets for traffic signal poles shown on the plans and in the pole/equipment schedule are approximate. The final location of each pole shall be staked in the field by the contractor and approved by the Engineer, to ensure that the edge of pole foundation is immediately adjacent (1-inch maximum) to the back of sidewalk, back of wheelchair ramp, or integrated into the sidewalk ramp design. The intent of these criteria is to ensure that the pedestrian push button assemblies are accessible to wheelchair-bound pedestrians.

731-3.03 Base Plates and Poles:

Anchor bolts, washers, and nuts required for relocating existing poles shall be furnished by the contractor.

Poles shall be drilled and tapped for mounting hardware as shown on the Standard Drawings. Use of through bolts will not be permitted.

Poles will be rejected if holes are not properly positioned for the required mounts.

All steel poles shall be plumbed to the vertical with all mast arms, signal heads and luminaires installed.

Sidewalks, curbs, gutters, pavement, base material, lawns, plants, and any other improvements removed, broken, or damaged by the contractor's operations shall be replaced or reconstructed with materials in accordance with these specifications. The replaced or reconstructed improvements shall be left in a serviceable condition satisfactory to the Engineer, and shall conform to these specifications where applicable.

Where existing pole installations are to be modified, materials and equipment shall be used, salvaged, or disposed of as specified in the Special Provisions and as directed by the Engineer.

Wood poles shall be placed in the ground to a depth of at least 6 feet. After each wood pole is set in the ground, the pole shall be backfilled with selected backfill. Backfill shall be free of large rocks and debris, and placed in layers of no more than 6 inches before compaction. Each layer shall be moistened and thoroughly compacted to the satisfaction of the Engineer.

Existing poles shall be either relocated or used in place as specified in the project plans. The contractor shall inspect the poles and provide the materials and work necessary to recondition the poles so they can be reused. Holes left in the shafts of existing poles, due to removal of items such as signal mounting assemblies, shall be repaired and painted with a zinc galvanized paint.

If any poles are damaged by the contractor's operations, such repairs or replacements shall be at no additional cost to the Department. If the Engineer orders additional work to be done following the contractor's inspection of the poles, such work will be paid for as provided in Subsection 109.04 of the specifications.

New poles that are damaged by improper drilling of holes will be rejected.

731-3.04 Removing and Replacing Improvements:

Wherever a part of a section or slab of existing concrete or sidewalk or curb is damaged by the contractor, the entire section between expansion joints shall be removed and the concrete reconstructed as directed by the Engineer.

All areas of concrete sidewalks and driveways and all areas of Portland cement concrete and asphaltic concrete pavements to be removed shall be outlined and cut to a minimum depth of 1-1/2 inches with an abrasive type saw prior to removing the material. The cut for the remainder of

the required depth may be made by any method satisfactory to the Engineer. Saw cuts shall be neat and true with no shattering or chipping of concrete adjacent to the outside of the removal area.

731-4 Method of Measurement:

The structural supports and foundations for traffic signals and highway lighting will be measured as a unit for each type of support and foundation furnished and installed.

Modification of existing poles and mast arms will be measured as a unit for each pole or mast arm modified.

731-5 Basis of Payment:

The accepted quantities of supports and foundations for signals and lighting, measured as provided above, will be paid for at the contract unit price each, for the type of support or foundation designated in the bidding schedule, complete in place, which price shall be full compensation for the work described and specified herein and on the plans, including all hardware, wire, excavation, backfill and incidentals necessary to complete the work.

The accepted quantities of modify pole and modify mast arm, measured as provided above, will be paid for at the contract unit price each, for the type of pole or mast arm designated in the bidding schedule to be modified, which price shall be full compensation for the work described and specified herein and on the plans, including all parts, hardware and incidentals necessary to complete the work.

No measurement or direct payment will be made for anchor bolts, the cost being considered as included in the unit price paid for foundations.

SECTION 732 ELECTRICAL UNDERGROUND MATERIAL:

732-1 Description:

The work under this section shall consist of furnishing and installing electrical conduit, conductors, and pull boxes for traffic signals and highway lighting including jacking, drilling, excavating, backfilling, and compacting at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

732-2 Materials:

732-2.01 Electrical Conductors:

Electrical conductors shall be stranded or single conductor, thermoplastic insulated electrical wire or cable. Conductors shall conform to the specifications of the NEC, UL, and other applicable industry standards.

Wire and cable for traffic signal, highway lighting and other electrical systems shall be UL listed and rated for 600-volt operation. The UL label shall be present on each reel, coil or container of wire or cable. When requested, the contractor shall submit to the Engineer the manufacturer's written certification that the product conforms to the requirements of these specifications.

All single conductors, except detector lead-in cables, shall have plain, distinctive and permanent markings on the outer surface throughout the entire length showing the manufacturer's name or trademark, insulation type letter designation, conductor size, voltage rating and the number of conductors in the cable.

The wire shall be annealed copper and shall be uncoated unless otherwise specified. The wire shall be solid for number 10 AWG and smaller, conforming to the requirements of ASTM B3 for annealed bare copper wire. Conductors for sizes number 8 AWG and larger shall be stranded and shall conform to ASTM B8 for Class B stranding. Unless otherwise specified, the conductors shall be insulated with THW grade thermoplastic compound and shall meet the requirements of UL 83. Insulation colors shall be permanent and an integral part of the insulation and shall not be applied as a surface treatment of coating. The insulation thickness shall conform to the requirements of the NEC. Conductor insulation shall be a solid color as specified in the conductor table unless otherwise specified. The color shall be continuous over the entire length of the conductor.

(A) Traffic Signal and Highway Lighting Conductors:

Conductors used for traffic signal and highway lighting systems shall conform to the requirements of the following table. The minimum conductor sizes shall be as shown in the following table unless otherwise specified.

CONDUCTOR TABLE

		INSULATION		CONDUCTOR		
CIRCUIT	SIGNAL PHASE OR FUNCTION	COLOR	TYPE	Minimum Thick. (MILS)	Minimum Gauge (AWG)	TYPE
Vehicle Signals	Red Interval	Red	THW	45	12	
	Yellow Interval	Yellow	THW	45	12	
	Green Interval	Green	THW	45	12	
Pedestrian Signals	Intl. Symbol Hand/Man	Red	THW	45	12	
		Green	THW	45	12	
Pedestrian Push-Button	Pedestrian Detection	Orange	THW	45	12	

CONDUCTOR TABLE						
Series Lighting	Series Loop	Black	THW 5 kv	150	8	S
Highway Lighting	Multiple Lighting	Black	THW	45	12	
Lighting in Pole	Pull box to Luminaire	Black	XHHW	30	12	S
Sign Lighting	Multiple Lighting	Black	THW	45	12	
Common	Common Lead	White	THW	45/60	12/8	
Spares	Unused Leads	Brown or Black	THW	45	12	
Detection	Detector Roadway Loops	Black Orange	THWN in PVC Tubing	15 31	14	S
Detection	Loop Detector Lead in Cable	Clear Black	PE Foil Shield Vinyl	32	14/16/18	STP
Detection	Magnetometer Lead in Cable	Red Black Green White	PE in PVC Jacket	18 18 18 18	18 18 18 18	S4C
	Service Service Common Bond	Black White Green or Bare	THW THW	AS AS AS	AS AS 8	

Legend:

AS = As Specified; PE = Polyethylene; S = Stranded;
STP = Stranded, twisted pair; S4C = Stranded, 4 Conductor

(1) Roadway Loop Detector Wire:

Roadway loop detector wire shall be a factory assembled combination of PVC tubing and wire. Loop detector wire shall be stranded number 14 AWG copper, rated at 600 volts with THWN insulation. The wire shall be enclosed in a factory extruded PVC flexible tubing by the wire manufacturer. Contractor assembly of the wire in the flexible tubing will not be acceptable.

The PVC tubing shall be UL FR-1 rated at 105 degrees C and have a moisture absorption of less than 1 percent. The wall thickness shall be 31 ± 3 mils with a nominal inner diameter of 0.186 inches. The tubing shall be orange in color, be highly resistant to chemicals and oils, and have a dielectric strength of 900 volts per centimeter.

(2) Wire Marking Tags:

Wire marking tags shall be made of flame retardant reinforced epoxy tape 5.5 mils in thickness and 1/4 inch minimum width. The tape shall be flexible, resistant to oil and water, and have a pressure sensitive acrylic adhesive backing. The adhesive shall be a high tack adhesive with good adhesion to clean neoprene, hypalon, nylon and PVC insulation materials. The film material shall conform to the flame retardant requirements of UL 510 and be rated at 150 degrees C. Appropriate numbers and letters shall be printed on wire tags for conductor identification.

(B) Cable:

(1) Shielded Cable:

Shielded cable used for loop detector lead-in cable and telephone coordination interconnect circuits shall be two-conductor, stranded, twisted pair, aluminum-polyester foil shield with 100 percent coverage, tinned copper with polyethylene insulation, vinyl jacketed, rated at 600 volts and 60 degrees C, and shall be in conformance with UL and the following table:

TABLE FOR SHIELDED CABLE		
AWG Size Number	14	16
Stranding	19 x 27	19 x 29
Insulation Thickness, inches	0.032	0.032
Jacket Thickness, inches	0.035	0.032
Outside Diameter, inches	0.340	0.274
Ground Wire AWG Number	16	18
Nominal Capacitance* (pF/ft)	24	24
Nominal Capacitance** (pF/ft)	47	47

Notes:

* Capacitance between conductors.
** Capacitance between one conductor and another conductor connected to the shield.

(2) Instrumentation Cable:

Instrumentation cable normally used for magnetometer detectors shall be a number 20 AWG four-conductor, low-capacitance cable suitable for both conduit and direct burial.

The cable shall be round and be less than 0.25 inches in overall diameter. The jacket shall be a weatherproof, high density, heavy duty, abrasion resistant, polyethylene material with a minimum thickness of 0.032 inches.

The cable shall have an interior moisture penetration barrier to prevent capillary absorption of water and be suitable for a temperature range of -60 degrees C to +80 degrees C.

Each conductor shall have thermoplastic insulation with a minimum thickness of 0.018 inches. The conductor to conductor capacitance shall not be greater than 18 picofarads per foot for adjacent pairs and 15 picofarads per foot for diagonal pairs with all other conductors disconnected.

(3) IMSA Cable:

IMSA cable shall be used only when specified on the plans. IMSA signal cables shall be polyethylene insulated copper conductors, polyvinyl chloride jacketed, rated at 600 volts for use in underground conduit or as aerial cable conforming to International Municipal Signal Association Specification No. 19-1.

The IMSA-19 cable shall be provided with the number and size of conductors as specified on the plans. The cable shall use the standard IMSA colors for conductor insulation. The colors and tracers shall be permanent and an integral part of the insulation, and shall not be painted, surface coated, or adhered to surface.

732-2.02 Electrical Conduit and Warning Tape:

All conduit and fittings shall be listed by UL, and conform to NEC standards. Except as specified below, all conduit to be installed underground or in concrete structures shall be rigid Polyvinyl Chloride (PVC) non-metallic type conforming to the requirements of UL 651 for Rigid Non-Metallic Conduit. PVC conduit and fittings shall be Schedule 40, heavy wall, manufactured from high impact material and shall be rated for use at 90 degrees C.

All exposed conduit and fittings to be installed above ground shall be the rigid metal type manufactured of galvanized steel conforming to requirements of UL 6 for Rigid Metallic Conduit. Non-threaded couplings shall not be used. Rigid metal galvanized steel conduit bends shall be used for entering pull boxes that are spaced more than 150 feet apart.

Intermediate metal conduit may be used in place of rigid metal conduit except for service risers. Galvanized intermediate metal conduit shall conform to the requirements of UL 1242. Intermediate metal conduit and fittings shall be manufactured from steel and work hardened to provide high strength. The exterior wall shall be hot-dip galvanized. Threads shall be fully cut and galvanized after cutting. All threaded fittings shall be the same as fittings approved for metal conduit.

Flexible conduit shall be a liquid-tight flexible metal type and shall be used as specified. The conduit shall be a flexible galvanized steel core over which is extruded a PVC cover. Approved liquid-tight fittings shall be furnished and installed with the conduit.

Sampling and testing procedures shall conform to UL Standards. Samples for testing, when requested by the Engineer, shall be furnished

at no additional cost to the Department. Samples of conduit shall be tested by UL standards and be approved for use by the Engineer prior to installation on the project.

Conduit warning tape shall be a 4-mil inert plastic film specially formulated for prolonged use underground. All tape shall be highly resistant to alkalis, acids, and other destructive agents found in the soil.

Tape shall have a continuous printed message warning of the location of underground conduits. The message shall be in permanent ink specifically formulated for prolonged underground use and shall bear the words, “CAUTION - ELECTRIC LINE BURIED BELOW” in black letters on a red background.

732-2.03 Pull Boxes:

Precast reinforced concrete pull boxes, covers and extensions shall be installed and located as shown on the project plans and shall be the size specified.

Chipped or cracked pull boxes, covers, and extensions will not be accepted.

Portland cement concrete shall conform to the requirements of Section 1006 of the specifications for Class B concrete. When requested by the Engineer, pull boxes, covers, and extensions shall be furnished for testing at no additional cost to the Department.

Covers shall be marked as follows:

“A.D.O.T. ELECTRICAL HIGH VOLTAGE”

Markings shall be clearly defined and uniform in depth and shall be placed parallel to the long side of the cover. Letters shall be 1 inch high.

732-2.04 Metal Junction Boxes:

Metal junction boxes and covers for installation in concrete structures shall be fabricated from a minimum of 16 gage type 304 stainless steel. All seams shall be continuously welded and shall conform to the dimensions and details shown on the project plans. A neoprene gasket with a thickness of 1/8 inch shall fit between the box and the cover. The cover shall be made to fit securely and shall be held in place with a minimum of four stainless steel machine screws. Tabs for ease of installation may be attached to the junction box at the option of the contractor.

732-3 Construction Requirements:

732-3.01 Installation of Electrical Conduit and Pull Boxes:

Conduit runs shown on the project plans shall be changed to avoid underground obstructions as directed by the Engineer.

The contractor may, at its option and at no additional cost to the Department, use a larger size conduit than specified provided the larger size is continuous for the entire length of the run from outlet to outlet. Reducing couplings will not be permitted. Changes in the location and size shown on the project plans shall be documented by the contractor and submitted to the Engineer.

The PVC conduit shall be cut square and trimmed to remove all rough edges. Conduit connections shall be of the solvent weld type. Purple primer conforming to the requirements of ASTM F656 shall be applied to the joined surfaces prior to use of cement. The joint cement shall be the gray PVC cement conforming to the requirements of ASTM D2564. Where a connection is made to steel conduit, the coupling used shall be a PVC female adapter.

Expansion fittings shall not be installed in PVC conduit runs between two pull boxes unless otherwise specified. Expansion fittings shall be installed in conduit runs in which both ends of the conduit are fixed in place such as between two foundations. Expansion fittings shall be installed in conduit runs which cross any expansion joint in a concrete structure. Approved expansion fittings shall allow for a linear thermal expansion of up to 6 inches.

If a trench has to be left open overnight, a minimum of 6 inches of backfill material shall be used as a protective cover to eliminate contraction of the conduit system. The backfill material shall be removed if final inspection by the Engineer has not been made.

Backfill containing large rock, paving materials, cinders, large or sharply angular substance, or corrosive material, shall not be placed in an excavation where materials may damage raceways, cable, or other substructures or prevent adequate compaction of fill or contribute to corrosion of raceways, cables or other substructures.

Where necessary to prevent physical damage to the raceway or cable, protection shall be provided in the form of granular or selected material, suitable running boards, suitable sleeves, or other approved means.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of the specifications.

All PVC conduit shall be stored and handled in an approved manner to minimize ultraviolet deterioration due to exposure to sunlight.

Conduits in protected areas such as behind curbs, in sidewalks, etc., that are not subject to any vehicular traffic shall be at a minimum depth

of 18 inches. Conduits installed under roadways, driveways or any open areas where it is possible for vehicles to drive and conduits with conductors that have voltages over 250 volts, shall be at a minimum depth of 30 inches. When conduit in protected and open areas cannot be installed at the minimum depths, it shall be encased in concrete.

Where specified due to shallow trenching depths, the conduit shall be encased in a minimum of 3 inches of concrete. The conduit shall be supported with masonry block or brick on 10-foot centers, during encasement, so that the conduit will be completely encased.

Installation of conduit for underground primary service shall conform to the utility company requirements, local codes and the Special Provisions. Conduit installed in railroad right-of-way shall be to the depth specified by the railroad company.

Except for factory bends, conduit bends shall have a radius of not less than that specified in the NEC. Conduit shall be bent without crimping or flattening, using the longest radius practicable.

Existing underground conduit to be incorporated into a new system shall be cleaned and blown out with compressed air.

Conduit for future use shall have a number 8 AWG bare bond wire installed with at least 2 feet of pull wire doubled back into the conduit and capped.

A 3-inch “Y” shall be cut into the face of the curb directly over conduit located under curbs.

The contractor shall place warning tape in all trenches in which new conduit is placed. All warning tape shall be buried at a depth of 6 to 8 inches below the finished grade.

Conduit entering pull boxes shall terminate a minimum of 3 inches inside the box wall. The conduit shall be between 2 and 4 inches above the bottom of the pull box and shall be sloped to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall be located near the sides and ends in order to leave the major interior portion clear. At all outlets, conduits shall enter from the direction of the run and allow for expansion and contraction.

Rigid metal conduit bends shall be used for entering pull boxes that are spaced more than 150 feet apart. The bends shall be 90 degrees and be of the same diameter as the connecting conduit. The bends shall be wrapped with an approved PVC tape.

Conduit ends shall be capped with conduit end cap fittings until wiring is started. When end caps are removed, PVC ends shall be provided with an approved conduit end bell. End bells shall be installed prior to

the installation of the conductors. Approved insulated grounding bushings shall be used on steel conduit ends.

Conduit embedded in concrete structures shall be securely attached to the reinforcing steel at intervals of approximately 12 inches. Expansion fittings shall be installed where conduit crosses expansion joints in the structure. Where bonding is not continuous, expansion fittings shall be provided with a bonding jumper of number 6 AWG flexible wire. Where it is not possible to use expansion fittings, sleeves of sufficient size shall be installed to provide a minimum 1/2-inch clearance between the conduit and the inside wall of the sleeve. The sleeve shall be discontinuous at the expansion joints.

All existing conduits and conduit embedded in concrete structures shall be cleaned out with a mandrel and blown out with compressed air.

Conduit shall be installed under existing pavement by jacking or drilling methods approved by the Engineer. Open trench excavation across an existing roadway shall not be permitted without the written permission of the Engineer. Jacking and drilling pits shall be kept 2 feet clear of the edge of the pavement. Pull boxes shall be installed in accordance with the details shown on the project plans and the standard drawings. Pull boxes shall be installed flush with the finished grade and when in concrete shall have a 1/2-inch felt expansion joint installed around all sides of the pull box. Junction boxes placed in concrete structures shall be flush with the finished concrete surface.

732-3.02 Wiring Procedures:

(A) General:

Wiring shall conform to the regulations and codes listed in Subsection 730-3 of the specifications, and of the NEC, and shall be UL listed and bear the UL labels and the following requirements:

The conductors shall be pulled into runs in a smooth continuous manner, avoiding contact with sharp objects that might damage the insulation. Approved lubricants shall be used for inserting conductors in conduit. Before installation, conductor ends shall be taped for moisture protection until connections are made.

Conductors shall have a minimum of 36 inches of slack from the conduit end bell in the pull box.

All ungrounded ballast primary leads shall be protected with fused in-line connectors. Unfused in-line connectors shall be installed on all ballast secondary leads. In-line connectors shall be fused with fast-acting, high-interrupting capacity fuses with a fault current rating of 100 kiloamperes at 600 volts AC. The in-line connectors shall be watertight, non-locking and rated at 600 volts AC.

(B) Splices:

In circuits where the voltage does not exceed 600 volts AC, splices shall be made utilizing approved spring-type wire connectors. Soldered connections will not be permitted unless so specified. The insulation for the splice shall consist of two layers of electrical rubber tape, four layers of plastic electrical tape and two layers of friction tape. The tapes shall be securely applied over the bare wire splice area and back onto the original insulation a minimum of 1 inch. A minimum of three coats of approved liquid waterproof splicing compound shall then be applied to the splice. The finished splices shall be such that their electrical and mechanical characteristics and insulation quality are equal to those of the original cable. Conductors shall be spliced only in pull boxes, terminal compartments, pedestals, or cabinets.

Splices for high-voltage series lighting conductors shall be made from an approved splice kit. The splices shall consist of either molded rubber plug-in connectors or epoxy resin mold type splice insulating kits and shall be rated at 5 kilovolts. The finished splice shall make a sealed waterproof connection which shall be equal to the original cable conductors and insulation.

Cable used for detector lead-in and telephone interconnect circuits shall be run continuous and unspliced to the controller cabinet. Unless otherwise shown on the plans, one lead-in cable shall be installed per loop detector except for 6 foot by 6 foot loop detectors.

Signal circuit conductors for each mast arm mounted signal assembly shall be continuous without splicing from the pull box, adjacent to the pole, to the terminal blocks in the mast arm assembly.

(C) Tagging:

All conductors shall be tagged to identify their circuit number or function with wire marking tags. The tag identification shall correlate with the conductor schedule shown on the project plans. The tags shall be furnished and installed by the contractor. Each tag shall be wrapped entirely around the conductor twice. Each signal wire shall be tagged as to phase, color indication, and function such as vehicle indication, pedestrian indication, or pedestrian push button (Phase 1 - Red, Yellow, Green, etc). Each phase group shall also be tied together and tagged. Each lighting circuit wire shall be tagged to identify the circuit number and other types of circuits. Black wires used as spares shall be tagged as spares.

(D) Testing:

(1) Signal Circuits:

Prior to control cabinet installation, the contractor shall apply 120 volts to signal circuits and verify equipment is operational. The Department will connect field wiring inside the control cabinet.

(2) Roadway Lighting Circuits:

The contractor shall connect field wiring to the load center terminals. Lighting circuits shall be energized for 100 hours as directed by the Engineer prior to final acceptance. Failures occurring during this test period shall be corrected.

Wires shall be tagged in control cabinets, load center cabinets, pull boxes, terminal compartments of signal mounting assemblies, or wherever splicing occurs.

732-3.03 Bonding and Grounding:

All metallic enclosures such as cabinets, pedestals, poles, conduit and cable sheaths shall be bonded to form a continuous grounded system. Non-metallic portions of the system such as PVC conduit shall have a bare copper bond wire or a green insulated copper bond wire installed with suitable connections to form a continuous grounded system. In all traffic signal conduits, the copper bond wire shall have green insulation. The insulation shall be removed from the bond wire in pull boxes from the point at which the wire leaves the bell end of the conduit.

At each service disconnect, cabinet foundation, or where otherwise specified, an approved copper-plated ground rod shall be installed. Each ground rod shall be a one-piece solid rod of the copper weld type or approved equal and shall be a minimum of 5/8 inch in diameter and 10 feet in length. The rod shall be driven vertically into the ground to a minimum of 9 feet below the surface. The ground rod may be located in a pull box. The service equipment neutral and the system grounding bond shall be connected to the ground rod with a copper-plated bolt or a brass bolt on the ground clamp.

Pole foundations shall have 25 feet of number 4 AWG bare copper conductor coiled and placed at the bottom of the excavation before concrete is poured. The conductor shall be connected to the pole grounding screw in the hand hole with an approved lug connector.

A ground resistance test shall be performed for each installed ground rod prior to final connection of the utility service. Pole foundation coil grounds shall be tested as determined by the Engineer in the field.

The ground resistance shall be measured with a three-terminal, fall of potential, direct reading, battery-powered earth tester with a 0.50- to 500-ohm scale or digital read-out. The 25-ohm reading shall be approximately at mid scale.

The test shall be performed according to the manufacturer's instructions and OSHA requirements. Two auxiliary copper clad ground rods shall be driven into the ground a minimum of 3 feet. The lateral spacing for each test rod shall be given in writing on the test report form and the spacing shall be approved by the Engineer.

All tests shall be performed in the presence of the Engineer and test results shall be written down, dated, and given to the Engineer for approval.

Each ground rod or foundation ground shall be isolated with the bond wires disconnected when the test is being performed. The resistance to ground shall be 25 ohms or less. If it is not, additional ground rods shall be installed as required at least 15 feet from the original ground and shall be bonded to it. The test shall then be repeated for multiple grounds as necessary to achieve proper grounding below 25 ohms. As many additional ground rods shall be installed as is necessary to achieve proper grounding of 25 ohms or less.

The test shall be performed when the soil is dry. The contractor shall not add any chemical, or salt solutions to any portion of the grounding system. All grounding rods and foundation grounds to be tested shall be installed a minimum of 10 days prior to testing unless otherwise determined by the Engineer in the field.

732-3.04 Service:

Service system components and their installation shall conform to regulations and codes listed in Subsection 730-3 of the specifications, NEC, UL, local applicable codes, and the requirements of the utility company providing service.

Service risers shall be PVC-mold or galvanized steel as specified. Fastening of the service risers shall be done through the use of suitable straps and wood screws a minimum of 1-1/2 inches in length. Tape, nails or other means of attachment shall not be used.

Plywood backing boards, when required, shall be 3/4-inch, medium density, paper faced and of an appropriate size to mount all the necessary components. An approved primer and two finish coats of light gray paint, conforming to Section 1002 of the specifications, and acceptable to the Engineer, shall be applied to the plywood before the components are mounted. Special care shall be taken to ensure that the edges are well sealed.

All safety switch and multi-breaker enclosures shall be provided with a padlock to prevent unauthorized persons from operating equipment of disconnects. Padlocks will be furnished by the Department.

Meter sockets, when required, shall be approved by the serving utility company. They shall be furnished and installed by the contractor. The

meter socket shall be located as shown on the project plans. Meter service inspection shall be approved by the Engineer prior to service connection by the utility company.

If work is required on existing high voltage and series lighting circuits, the contractor shall obtain daily safety circuit clearance from the Department and the serving utility company prior to any work being done.

Signs painted “Danger-High Voltage” and “Arizona Department of Transportation” shall be installed permanently by the contractor on all Department electrical service structures. These signs will be furnished by the Department.

Fused cutouts on the voltage side of a series lighting service structure shall be pulled out and safety signs shall be furnished by the contractor and posted on the cutouts before any work is done. The signs shall be painted “Danger-High Voltage” and shall give the name of the company doing the work.

732-4 Method of Measurement:

Conductors (for lighting) will be measured by the linear foot for each gage size as follows:

(A) From center to center of pull boxes;

(B) From edge of foundation to center of pull box;

(C) From edge to edge of foundation;

(D) From end of conduit to center of pull box; and

(E) From end to end of conduit when no pull boxes are used.

Conductors (for signals and lighting) will be measured as a complete unit of work. This method of measurement shall be used for signal and lighting conductors shown in the signal conductor schedule on the project plans.

No measurement or direct payment will be made for conductors in poles and pull boxes, the cost being considered as included in the contract price for the pole and pull box items.

Conduit will be measured by the linear foot for each diameter size as follows:

(A) From center to center of pull boxes;

(B) From edge of foundation to center of pull box;

(C) From edge to edge of foundation;

(D) From end of conduit to center of pull box or foundation; and

(E) From end to end of conduit when no pull boxes are used.

Pull boxes will be measured as a unit for each pull box.

732-5 Basis of Payment:

732-5.01 Conductors (for Lighting):

The accepted quantities of conductors (for lighting), measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the item, complete in place.

732-5.02 Conductors (for Signals and Lighting):

Conductors (for signals and lighting), measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place.

732-5.03 Conduit:

The accepted quantities of conduit, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the work, complete in place, including excavation, backfill and any incidentals necessary to complete the work. No direct payment will be made for rigid metal conduit bends or rigid non-metallic conduit bends at pull boxes, expansion fittings and coupling fittings, the cost being considered as included in the contract price for the conduit items.

732-5.04 Pull Boxes:

The accepted quantities for pull boxes, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place, including any excavating and backfilling necessary to complete the work.

SECTION 733 SIGNAL INDICATIONS AND MOUNTING ASSEMBLIES:

733-1 Description:

The work under this section shall consist of furnishing and installing or modifying traffic signal indication assemblies, pedestrian signal indications, flashing beacons, and mounting assemblies at the locations

shown on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

733-2 Materials:

733-2.01 Signal Indications:

All new signals, except the programmed visibility and the pedestrian types, installed at any one intersection shall be of the same manufacturer and of the same material.

All traffic signal indication housings, pedestrian, indication, housing backplates, visors, louvers, mounting assemblies, and push button stations, shall receive a minimum of two coats of dull black enamel. Painting shall be done by the manufacturer.

(A) Standard Signal Faces:

Each vehicle signal face shall be of the adjustable vertical type with the number and type of sections specified on the plans.

Adjustment shall permit rotation of 360 degrees about a vertical axis. Each vehicle signal face shall provide an indication in one direction only.

Unless otherwise shown on the plans, all vehicle signal faces shall contain three sections arranged vertically; red-top, yellow-center, green-bottom.

Signal faces shall be standard 8-inch or 12-inch lens size.

(1) Optical Equipment:

Each optical unit shall consist of a lens, a reflector or reflector assembly, a lamp holder, and a clear traffic signal lamp of the appropriate size and type as specified herein or in the Special Provisions. The optical units shall conform to ITE Standards and ANSI Standard D 10.1.

(a) Lenses:

All traffic signal face lenses shall be glass unless otherwise specified on the plans.

Lenses shall be of the color indicated, circular in shape, with a nominal visible diameter as indicated on the project plans and of such design as to give an outward and downward distribution of light with a minimum above the horizontal. Each lens shall be true to color, of the best quality glass, free from imperfections, and provide high illumination transmission. Lenses shall conform to ITE Standards.

(b) Reflectors:

Each reflector shall be a single piece of silvered glass or specular aluminum with an anodic coating. Reflectors shall conform to ITE Standards. An opening in the back of the reflector for the lamp holder shall be constructed so that there will be no dark spots cast on the lens.

(c) Lamp Holders:

The lamp holder shall have a heat-resistant molded phenolic housing and be designed to accommodate up to a 150-watt standard A-21 traffic signal lamp, in the proper focal position.

(d) Lamps:

Lamps to be used in vehicular traffic signal faces shall conform to the standards set forth in the ITE publication "Standard for Traffic Signal Lamps" and the following table, unless otherwise specified:

TRAFFIC SIGNAL LAMP TABLE						
Nominal Size	**Bulb Type**	**Lens Color**	**Initial Lumens**	**User-Hours**	**Rated Wattage**	**Light Center Length**
8 inch	A19	Green Yellow	610	8000	60	2-7/16 inch
8 inch	A19	Red	1040	8000	90	2-7/16 inch
12 inch	A 21	Green Yellow Red	1750	8000	135	3 inch
Pedestrian Indication	A 21	White Orange	1750	8000	135	3 inch

All lamps shall be rated at 120 volts AC.

Lamps shall be clear and have an aluminum reflector disc. Projection type filaments shall be used, and supported at seven points. Name of manufacturer, wattage, voltage, and user-hours shall be etched on lamps. Amount of krypton gas shall be not less than 80 percent of the total fill gas of the lamp. If requested by the Engineer, the lamp manufacturer shall provide a report by an independent testing laboratory certifying the beam candle power and composition of the fill gas.

(2) Hardware:

Hardware for a standard signal section shall include a one-piece hinged door, a simple locking device, housing for lenses and other optical components, water-tight gaskets, terminal block and wiring. The sections shall be interchangeable and so constructed that sections can be added or removed. All exterior hardware such as hinge pins, bolts, screws, and locking devices shall be of 304 or 305 stainless steel. All interior screws and fittings shall be stainless steel or approved non-ferrous corrosion resistant material.

(a) Housing:

The housing for each signal section shall be a one-piece, corrosion resistant die cast or permanent mold cast aluminum conforming to ITE Standards.

The housing of each section shall be designed to permit access to the section for relamping without use of tools. Fittings and locking devices shall conform to the details of the Standard Drawings. The reflector, reflector ring, lamp holder, and spring wire bail shall be designed so they may be removed or replaced without the use of tools.

(b) Door:

The door shall be suitably hinged and securely held to the housing by hinge pins and locking devices.

(c) Gasketing:

Lamp holder gaskets shall be of material not affected by heat. All other gaskets, including door, lens and reflector gaskets, shall be of weather-resistant neoprene.

(d) Terminal Blocks and Wiring:

The terminal block for a standard three-section signal shall be a four-position, eight-terminal barrier-type strip mounted in the back of the middle unit. To the left of each terminal strip shall be attached the white, red, yellow, and green signal section leads and the opposite terminals shall be for field wires. The wires from the terminal block to the lamp socket shall be minimum size number 18 AWG, type TFF, 30-mil insulation thickness and rated at 105 degrees C.

(3) Visors:

Each signal section shall have an 11-inch to 12-inch long tunnel-type visor which shall be fabricated from number 3003 H-16 aluminum alloy. Visor shall conform to ITE Standards and details of the plans.

(4) Backplates:

Louvered backplates shall be furnished and installed on all vehicular signal sections. Anodized aluminum sheet, 16 gage, shall be used. All 12-inch signal faces shall have 5-inch backplates installed. All 8-inch signal faces shall have 8-inch backplates installed. All backplates shall have a 2-inch fluorescent yellow border of retroreflective tape conforming to ASTM Type XI reflective sheeting requirements.

(5) Directional Louvers:

Where shown on the plans, directional louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visors. The cylinder and vanes shall be fabricated from 5052-H32 aluminum alloy. Dimensions of louvers and vane configuration shall be as shown on the plans. The outer cylinder and the vanes shall be 0.032 inches minimum thickness, and the vanes shall be 0.016 inches minimum thickness.

(B) Programmed Visibility Signal Faces:

(1) General:

Each programmed visibility signal face shall conform to the provisions in Subsection 733-2.01(A) of the specifications, except the provisions for optical equipment shall not apply. The programmed visibility signal section shall provide a nominal 12-inch diameter circular or arrow indication.

Each section shall be provided with a sun visor and an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal axis. The visibility of each programmed visibility signal face shall be adjustable within the signal for the lanes in which traffic is to be controlled. When unprogrammed, the indication shall be visible from anywhere within 15 degrees of the optical axis.

(2) Optical Requirements:

The components of the programmed visibility signal face optical assembly shall be a circlet reflector, optical limiter-diffuser and objective lens conforming to ITE Standards. A circlet reflector with a specular inner surface shall join the lamp to the diffusion element.

The optical limiter-diffuser shall provide an image focused for objects at a distance of 900 to 1,200 feet limited by a veiling system.

The objective lens shall be a high resolution planar incremental lens, hermetically sealed with a flat laminate of weather resistant acrylic. The lens shall be symmetrical and able to be rotated to any 90-degree orientation about the optical axis.

Each signal section with a yellow indication priority programming shall provide a minimum luminous intensity of 3,000 candelas on the optical axis and a maximum intensity of 30 candelas at 15 degrees horizontally from the axis. Each section shall be capable of having visibility programmed for a minimum 3,000 candelas at 2 to 15 degrees horizontal from the axis. Under the same conditions, the intensities of the red indication and the green indication shall be at least 19 and 35 percent, respectively, of the yellow indication.

(3) Lamps and Dimming Devices:

The lamp for each signal section shall be a nominal 150-watt, sealed beam, 120-volt, 6,000-hour minimum rated life lamp as specified. During daylight, the signal indications shall be visible only in the lanes designated. For nighttime operation, dimming devices shall be provided to reduce the intensity by 15 percent.

(4) Terminal Blocks:

Terminal blocks shall conform to the provisions in Subsection 733-2.01(A)(2)(d) of the specifications.

(C) Fiber Optic Turn Arrow Signal:

(1) General:

Each fiber optic signal unit shall conform to the provisions in Subsection 733-2.01(A) of the specifications except the provisions for optical equipment.

The signal unit shall display alternate legends, consisting of either a green or yellow directional arrow.

The signal unit shall be clearly legible under any lighting conditions within a 20-degree cone of vision centered about the optical axis. Visors or hoods shall have a weatherproof housing and door and shall not be required for legibility.

The signal unit shall consist of a fiber optic module with individual output lenses, color filters for specified legend colors, required light sources and transformers.

A separate lamp shall be used for each display, and lamps shall be rated between 10.5 and 10.8 volts. The rated lamp life shall not be less than 8,000 hours.

Nineteen individual lenses, 5/8 inch in diameter, shall be fitted over the end of each fiber optic bundle to form the arrow legend. The same lenses shall be used for both displays. Fiber optics shall be glass fiber bundles assembled on a flat black matrix panel. Individual fiber optic bundles shall not be jacketed or encased. The signal shall supply approximately 50 percent more light to the lenses when displaying a green arrow in order to balance the intensity between colors. No color shall appear in the lenses when not illuminated regardless of sunlight intensity.

(2) Hardware:

The complete signal unit shall be mounted in a standard aluminum 12-inch round signal case. An aluminum front panel 12 inches in diameter

and lens mounts shall be colored black to minimize legibility of arrow when not illuminated.

All fiber optics, transformers, and lamps shall be mounted on the door of the unit. Lamps shall be mounted horizontally to prevent their collecting water from condensation or possible gasket leaks. No moving parts are permitted.

All screws, washers, nuts and bolts shall be corrosion resistant. All components shall be readily accessible when the door is opened. Maintenance or replacement of components shall require only simple tools.

(3) Transformers:

A separate transformer having Class A insulation rated at 48.5 volt-amps shall be used for each color display to reduce the voltage to 10.5 volts AC.

(4) Temperatures:

The fiber optic signal assembly shall be capable of continuous operation over a temperature range of -35 to +165 degrees F.

733-2.02 Pedestrian Signals:

Neon international man/hand symbol pedestrian signals shall be furnished and installed unless specified otherwise.

Pedestrian signal assemblies shall be complete and operational with the international man/hand symbol indications, and the mounting assemblies shall be furnished and installed by the contractor as shown on the plans.

(A) Neon Pedestrian Signal Indications:

(1) General Requirements:

The maximum overall dimensions of the pedestrian unit including the visor shall be 18-1/2 inches wide, 18-3/4 inches high, and 9 inches deep. The man/hand symbols shall be in a single housing containing both message symbols.

The pedestrian signals shall be energy efficient, with a maximum energy usage of 20 watts, at 120 volts.

(2) Case:

The case shall be a one-piece, corrosion-resistant, aluminum alloy die casting, complete with integrally cast top, bottom, sides and back. Four

integrally cast hinge lug pairs, two at the top and two at the bottom of each case, shall be provided for operation of a swing-down door.

The case shall be properly matched to other pedestrian signal components to provide a dustproof and weatherproof enclosure and shall provide easy access to replace all components.

(3) Door Frame:

The door frame shall be a one-piece, corrosion resistant, aluminum alloy die casting, complete with two hinge lugs cast at the bottom and two latch slots cast at the top of each door. The door shall be attached to the case by means of two type-304 stainless steel spring pins. Two stainless steel hinged bolts with captive stainless steel wing nuts and washers shall be attached to the case with the use of stainless steel spring pins. Latching or unlatching of the door shall not require tools.

(4) Solid State Message Module:

A molded support tray manufactured from black polycarbonate plastic shall protect the two neon tube light sources and the solid state controller.

The tube for the "Hand" symbol shall be 10 millimeters in diameter and be coated on the inside with Portland orange fluorescent material. The tubing for the "Walking Man" symbol shall be 9 millimeters in diameter and be coated on the inside with lunar white fluorescent material. Both shall be formed and positioned for maximum intensity.

The message lens shall consist of a 1/8-inch minimum thickness clear U.V.-stabilized, refractor-type polycarbonate plastic with outer prisms and shall be heat, craze, and water resistant.

The two neon compartments shall be sealed into an integral assembly with a one-piece sponge gasket fitted around the perimeter to protect the enclosed neon tubing from handling and weather.

Solid State circuitry shall be assembled on circuit boards as necessary to energize to high voltage flyback transformers and the neon tubes.

Each controller circuit shall be sealed into an integral assembly with a one-piece sponge fitted around the perimeter to protect the enclosed neon tubing from handling and weather.

The entire unit including neon tubing and solid state controller shall have a factory warranty of five years against defects in workmanship or materials.

Each controller circuit shall be powered from 120-volt AC, 60-hertz and shall have a power factor of 90 percent minimum.

(5) Messages:

Messages shall be the Portland orange "Hand" and the white "Walking Man" illuminated by multiple configuration neon tubes encased in the plastic solid state message module. The symbols shall be a minimum of 12 inches in height and 7 inches in width and shall be configured as shown in the MUTCD.

The inside face of the message lens shall be painted in all areas except where the desired symbols are formed. The first coating of paint shall be black to form a contrasting background. The second coating shall be white to reflect internal light in between symbols.

(6) Visors:

The visor shall be the crate type to eliminate sun phantom and shall be 1-1/2 inches deep.

The crate assembly shall contain a minimum of 21 zigzag-pattern horizontal louvers and 20 straight horizontal louvers. Every other formal louver shall be reversed to form 1-inch diamond shaped cells. The material used for the visor shall be 0.030 inches thick and shall be 100 percent impregnated black polycarbonate plastic with a flat finish.

(B) Incandescent Pedestrian Signal Indications:

(1) General Requirements:

Each incandescent pedestrian signal shall consist of a housing, two-color message plate, a reflector assembly, two incandescent lamps and a front screen.

The pedestrian signal shall be furnished complete with incandescent lamps as described herein.

The overall maximum dimensions of each housing, including the front screen, shall be 18-1/2 inches wide, 18-3/4 inches high, and 11-1/2 inches deep.

(2) Case and Door Frame:

The case and door frame for the incandescent pedestrian signals shall conform to the requirements of Subsection 733-2.02(A) of the specifications.

(3) Message Lenses:

Each message lens shall be one-piece and shall be made of 1/8-inch minimum thickness, ultraviolet-stabilized polycarbonate or 3/16-inch

thick tempered glass. Either lens shall have a textured outside surface to eliminate message "hot spots".

(4) Reflector:

Each reflector shall be a single-piece double-parabolic reflector constructed from textured plastic or aluminum. All reflectors shall conform to the requirements of ITE Standards. Plastic reflectors shall consist of vacuum-formed polycarbonate with a vacuum-deposited aluminum reflector surface and shall not distort when used with a lamp of specified wattage normally used in the signal.

(5) Lamp Holder:

Each lamp holder shall be positioned so as to be centered and pre-focused in its respective position when an A21 bulb with medium base is used. The lamp holder shall be made of molded phenolic and shall have a brass screw shell with lamp grip.

(6) Visor:

Each incandescent pedestrian signal shall be provided with an egg-crate type visor designed to eliminate sun phantom.

The crate assembly shall consist of 15 vertical members and 26 horizontal members plus two integral locking strips to prevent vandalism. The vertical spacing of the horizontal member shall be 1/2 inch. The completed egg-crate portion shall be 1-1/2 inches deep.

The material for the crate visor shall be as specified in Subsection 733-2.02(A)(6) of the specifications.

(7) Wiring and Terminal Blocks:

Each lamp socket for incandescent pedestrian signals shall be provided with one red lead for "Hand" symbol and one green lead for "Walking Man" and one white lead from the shell. Leads shall be number 18 AWG and shall be wired to respective terminals of a three-terminal block. The two white wires shall be connected to a common terminal.

733-2.03 Flashing Beacons:

Flashing beacons shall consist of one or two signal sections as designated on the project plans, conforming to the provisions in Subsection 733-2.01(A) of the specifications. A yellow or red lens shall be used as specified on the project plans.

(A) Overhead Flashers:

The overhead flashing beacon shall consist of two signal sections mounted on a cantilever arm assembly. Each overhead assembly shall incorporate 12-inch signal sections with yellow lenses unless otherwise specified. The "Signal Ahead" sign to be mounted on the mast arm will be furnished by the Department unless otherwise specified.

(B) Pole Flashers:

Each pole flasher shall consist of two signal sections. Each pole flasher assembly shall contain 8-inch signal sections with yellow lenses.

(C) Control Equipment Housing:

The control equipment housing shall be a Type I load center cabinet as shown in the plans unless otherwise specified.

733-2.04 Mounting Assemblies:

Mounting Assemblies shall consist of terminal compartments and assemblies of 1-1/2 inch nominal standard pipe and fittings. All members shall be so fabricated that they shall provide plumb, symmetrically arranged, and securely fabricated assemblies.

Terminal Compartments: A terminal compartment shall be assembled in the mounting brackets as shown in the Standard Drawings. The terminal compartment shall be manufactured of bronze, Type 356-T6 aluminum, or ductile iron.

Each terminal compartment shall be fitted with a 12-position, 24-terminal block. Each type of mounting assembly shall be supplied with wiring from the terminal block through the support arm which holds the signal. This wiring shall be in the form of color-coded wire leads with spade terminals for connecting to signal head, and soldered ends for connecting to terminal strips in the terminal compartment. The wiring shall be colored-coded as follows:

White	Common to all heads
Red	Red lens head
Yellow	Yellow lens head
Green	Green lens head

The leads shall be minimum number 16 stranded AWG Type-THW with 30-mil thermoplastic insulation. Leads shall be of sufficient length to extend from the center section of the signal head to the top of the terminal compartment. Terminal compartment wire hookup shall be as follows:

Top terminal	Phase A Red
Next terminal	Phase A Yellow
Next terminal	Phase A Green
Next three terminals	Phase B R-Y-G

Bottom terminal	Common - White

A rainproof cover shall be provided for all terminal compartments which will provide ready access to the internal terminal block wiring.

The types of frameworks used and the methods of mounting them shall be as shown on the plans or specified in the Special Provisions.

733-3 Construction Requirements:

Construction shall be such that all conductors are concealed within assemblies. Cable guides shall be used to support and protect conductors entering through poles. All threads shall be coated with rust-preventive paint during assembly.

Each vehicle, pedestrian signal, or flasher assembly shall be mounted at the location and in the manner shown on the project plans.

When signal faces are mounted on a mast arm, the plumbizer when specified shall be placed on the mast arm, and a 3/8-inch by 4-inch bolt shall be used to fasten both together.

Materials removed and not designated to be salvaged or incorporated into the work shall become the property of the contractor.

All traffic signal heads not in use shall be covered with burlap and shall be unmistakably out of service when observed by an approaching driver. Plastic coverings shall not be allowed.

733-4 Method of Measurement:

Traffic signal faces, pedestrian signal faces, traffic signal mounting assemblies and flashing beacons will be measured as a unit for each type of signal face, mounting assembly or flashing beacon furnished and installed or modified.

733-5 Basis of Payment:

The accepted quantities of traffic signal faces, pedestrian signal faces, traffic signal mounting assemblies and flashing beacons, measured as provided above, will be paid for at the contract unit price each, for the type signal face, mounting assembly or flashing beacon designated in the bidding schedule, complete in place, which price shall be full compensation for the work described and specified herein and on the plans, including visors, backplates, lamps and all hardware necessary to provide a complete, functional, traffic signal installation.

No direct payment will be made for assembly of Department-furnished items, the cost being considered as included in the contract price bid for the item in place.

SECTION 734 TRAFFIC CONTROLLER ASSEMBLY:

734-1 Description:

The work under this section shall consist of furnishing and installing traffic controller assemblies at the locations shown on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

A traffic controller assembly shall consist of a complete assemblage of electrical equipment and components for controlling the operation and timing of traffic control signals.

734-2 Materials:

The controller assembly shall include the controller unit, all necessary auxiliary equipment, the controller cabinet, concrete foundation, conduit, elbows, anchor bolts and clearance pad.

The auxiliary equipment shall include all appurtenances such as flasher controls, loop detector amplifiers, power assemblies, signal load switches, conflict monitors, pre-emptors, controllers, coordinators, time switches, external logic, lighting controls, cabinet wiring and accessories as indicated on the plans or in the Special Provisions.

The entire surface area of each circuit board shall be sealed to protect against moisture.

The following auxiliary equipment shall be furnished with all wired traffic controller assemblies when required:

Controller;
Power Panel;
Signal Load Switches;
Signal Conflict Monitor;
Detectors;
Controller Flasher Assembly;
Flash Switches;
Surge Protector;
Radio Interference Suppresser;
Cabinet Ventilation Fan;
Terminal Tie Points; and
Field Terminals

734-2.01 General Requirements:

The traffic controller assembly equipment shall conform to the requirements of the current edition of NEMA Publication TS-1.

(A) Documentation:

The contractor's material proposal shall include complete technical information, shop drawings, photographs, graphs, circuit diagrams, instruction manuals, and any other necessary documents to fully describe the proposed traffic controller assembly items.

At the time of delivery, the contractor shall furnish three sets of instruction books and an itemized price list for each type of equipment, their sub-assemblies, and their replacement parts.

The instruction books shall include the following information:

(1) Table of Contents;

(2) Operating Procedure;

(3) Theory of Operation;

(4) Step by step maintenance and trouble-shooting information for the entire assembly and for all components capable of being adjusted;

(5) Circuit Wiring Diagrams;

(6) Pictorial Diagrams of Parts Locations; and

(7) Parts Numbers.

The instruction manuals shall include itemized parts lists. The itemized parts list shall include the manufacturer's name and part number for all components (such as transistors, integrated circuits, diodes, switches, resistors, capacitors, relays, etc.) used in each circuit module. The list shall also include cross-references to parts numbers of other manufacturers who make the same replacement part.

(B) Warranties:

Each controller unit and all of its auxiliary equipment shall be warranted by the supplier against all defects in materials and workmanship in accordance with Subsection 106.13 of the specifications with the additional requirements as specified hereinafter.

The warranty for the controller unit and its auxiliary equipment shall provide that in the event of malfunction during the warranty period, a like controller unit, module, or auxiliary equipment shall be furnished, within three working days, for use while the warranted unit is being repaired. The isolation of any malfunction and the repair and/or replacement of any device within the warranty period shall be the responsibility of the supplier.

The Department reserves the right to reject equipment of a specific model type in which the Department has determined that its past field performance has been unsatisfactory. The Department's rejection of an item shall be final.

(C) Certificate of Compliance:

A Certificate of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for each traffic controller assembly. The Department reserves the right to require Certificates of Compliance for each controller assembly component.

The Department reserves the right to perform tests on any equipment supplied by the contractor in the Department's testing facilities.

(D) Pre-Approval of Controller Equipment:

The Department will only accept equipment furnished by manufacturers or vendors with proof of liability insurance for controller units, conflict monitors, load switches, flashers, and flash relays, and which have been pre-approved by the Department.

All traffic signal controller units shall be tested by the Department's testing procedures and be pre-approved by the Department. Pre-approved traffic signal controller units will be listed in the Special Provisions. Any controller unit and specified component not listed in the Special Provisions will not be accepted.

The Department reserves the right to re-test any pre-approved equipment supplied by the contractor in the Department's testing facilities.

The following includes all traffic signal controller units that have been tested and preapproved as specified by the Department as per these specifications.

The following controller equipment has been pre-approved by the Department as of January 2014:

(1) Type MPS Controllers: Special Programmable and System Applications (TS2, Type 2 - Downward Compatible TS1):

(a) Siemens Corporation:

EPAC M53 with the following special programs:

MPS-SI	Computer Supervised Unit
MPS-P	Pre-emption

MPS-T-C	Time Base and Traffic-Actuated Coordination
MPS-M	Arterial Master Controller

(b) Econolite Control Products Inc:

ASC/3 with the following special programs:

	ADOT Basic Program Configuration
MPS-SI	Computer Supervised Unit
MPS-P	Pre-emption
MPS-T-C	Time Base and Traffic-Actuated Coordination
MPS-M	Arterial Master Controller

ASC/2-1000 with the following special programs:

MPS-SI	Computer Supervised Unit
MPS-P	Pre-emption
MPS-T-C	Time Base and Traffic-Actuated Coordination
MPS-M	Arterial Master Controller

Colbalt with the following special programs:

	ADOT Basic Program Configuration
MPS-SI	Computer Supervised Unit
MPS-P	Pre-emption
MPS-T-C	Time Base and Traffic-Actuated Coordination
MPS-M	Arterial Master Controller

(c) Intelight Inc:

NEMA Controller X series with the following special programs:

MPS-P	Pre-emption
MPS-T-C	Time Base and Traffic-Actuated Coordination
MPS-M	Arterial Master Controller

(d) McCain ATC ex:

ATC eX with the following special programs:

MPS-SI	Computer Supervised Unit
MPS-P	Pre-emption

MPS-T-C	Time Base and Traffic-Actuated Coordination

(2) NEMA Conflict Monitors:

(a) Eagle:

3 Channel	LT-213
6 Channel	LT-216
12 Channel	LT-222

(b) Econolite:

3 Channel	NCMU-3
6 Channel	NCMU-6
12 Channel	NCMU-12

(c) E.D.I.:

3 Channel	NSM-3L
6 Channel	NSM-6L
12 Channel	NSM-12L
16 Channel	MMU-16LE
16 Channel	MMU2-16LE

(d) Solid State Devices:

3 Channel	NM(NP)-3L
6 Channel	NM(NP)-6L
12 Channel	NM(NP)-12L
18 Channel	LCD-18P

(e) Transyt Corporation:

3 Channel	Model 300
6 Channel	Model 600
12 Channel	Model 1200

(f) Traffic Control Technologies:

3 Channel	LSM-3
6 Channel	LSM-6
12 Channel	LNM-12E
12 Channel	LMN-12E

(3) Other Controllers:

(a) NEMA Controllers:

Software	Protocol
Econolite ASC/2 and ASC/2S	NTCIP
Econolite ASC/3	NTCIP
Econolite ASC/2	AB3418
Peek 3000/3000E ATC-1000	NTCIP
Eagle M50/M52	NTCIP

(b) Type 2070 and ATC Controllers:

Software	Protocol
US Traffic ATC	NTCIP
Econolite 2070 ASC/2 and ASC/3	NTCIP
Eagle SEPAC	NTCIP
Siemens NextPhase	NTCIP
Fourth Dimension D4	NTCIP
NWS Voyage	AB3418E
Intelight	NTCIP
McCain Omni eX (basic status)	NTCIP

(E) Department Testing of Control Equipment:

A completely wired controller assembly with wiring diagrams and instruction books shall be delivered for inspection and testing unless otherwise specified. The equipment shall be delivered to:

Arizona Department of Transportation
Traffic Operations Services
Traffic Signal Shop
2104 South 22nd Avenue
Phoenix, Arizona 85009

It shall be the responsibility of the contractor to correct or replace any equipment that fails Department testing. Such corrections or replacements shall be as directed by the Engineer.

(F) Department Testing Procedures of Bid Items:

The traffic controller assembly shop test procedure shall be as follows:

(1) The contractor shall deliver the equipment to the Traffic Signal Shop;

(2) The Department will take inventory of the delivered equipment;

(3) The Department will conduct a load test for a minimum of 72 hours under on-line conditions;

(4) Environmental or other tests will be performed by the Department at the discretion of the Engineer;

(5) After any test failures, the contractor shall have three working days to correct the failure. Procedures (3) and (4) above shall then be repeated until the equipment passes the tests. The Engineer may require the replacement of any component after that component's second failure under test;

(6) After the controller operation tests are approved, the contractor shall pick up the control cabinet and equipment, haul them to the job site, and install them as specified. After the contractor has mounted the control cabinet on the cabinet foundation, Department personnel will connect all the field wiring inside the control cabinet and test the signal circuits; and

(7) Scheduling the activation of traffic signals shall require a minimum of 10 working days notice to the Department's Electrical Inspection Unit at 2104 South 22nd Avenue, Phoenix, Arizona 85009, (602) 712-7312. No activations outside the Phoenix metropolitan area shall be scheduled either on Monday or Friday. The Contractor shall be responsible to ensure that all the required work has been completed and that the traffic signals are ready to be activated on the pre-arranged date. If the Department determines that the traffic signal work is not complete and cannot be activated, then the contractor shall be responsible for costs incurred by the Department (personnel, equipment, lodging, per diem, salary etc.).

734-2.02 Traffic Signal Controllers:

A traffic signal controller shall consist of an electronic device dedicated to the selection and timing of traffic movements. Each controller shall provide all the features, functions and phasing operations as indicated on the plans and the Special Provisions.

(A) Solid State Digital Controllers:

The solid state digital controllers shall utilize modular construction, solid state circuitry, and digital timing techniques. Integrated or discrete semiconductor devices shall be used exclusively.

Controller logic shall have high noise immunity.

Solid state components shall be standard production types and shall be readily available.

Components shall be properly rated with respect to heat dissipating capacity and rated voltage.

The minimum rated life of all components shall be 10 years under 24-hour-a-day operation.

Components shall be clearly identifiable by markings on circuit boards or parts numbers on pictorial diagrams.

The digital timing techniques and repeatability shall be accordance with:

(1) Module Circuit Boards:

The controller shall contain plug-connected module boards. The solid state components shall be mounted on printed circuit module boards.

The module boards from the controller shall be easily removed without the use of special tools and shall be designed to permit replacement of all components without damage to the board or its circuits. Each individual printed circuit board shall be identified by a serial number or parts number clearly stamped or etched on the board.

The module circuit boards shall be arranged by functional groupings.

Each module board by functional design shall be electrically and mechanically interchangeable with other controllers of the same model, controller series, or frame type.

The module boards shall be fabricated from epoxy glass laminate NEMA grade G-10 or G-11, with a minimum weight of 2 ounces of copper per square foot. The copper track shall have adequate cross-section to carry the designed current capacity. All contact surfaces shall be non-corrosive construction. The entire surface area of each circuit board shall be sealed to protect against moisture.

Phase timing modules which time more than one phase shall be programmable to permit the selective disabling of unused phases.

Modules that have a 120-volt AC input shall be properly fused within the controller.

The interfaces and the power supply for the controller shall be designed to accommodate the maximum module configuration possible for the controller such that no additional future modifications are required.

Interchangeable connectors (except data buss type) shall be keyed to prevent their insertion into the wrong receptacle of the controller.

The controller's housing shall be an integral frame assembly constructed of non-ferrous metals. The housing shall conform to all NEMA requirements.

(2) Volatile Memory:

All volatile memory in controllers, time switches, and time base coordinators shall utilize a battery back-up supply to maintain memory as follows:

(a) Complete memory retention for 30 days if RAM board is removed from controller;

(b) Non-rechargeable Battery: The non-rechargeable battery shall be rated to maintain memory for not less than five years in continuous use and include a battery condition indicator; and

(c) Rechargeable Battery: The rechargeable batteries shall be the type that can be operated, stored, or charged in any position and be capable of being recharged not less than 1,000 times. The rechargeable batteries shall have an automatic battery charger with a battery discharge indicator and shall operate within the NEMA environment standards.

(3) Indicators:

Indicators shall be the sub-miniature type and may be either incandescent lamps or solid state. Incandescent lamps shall be replaceable from the front of the panel.

All programming pins shall be the printed circuit receptacle, non-corrosive, turning fork type. The pin contactor shall fit any standard 0.055-inch to 0.73-inch board. The pin shall be rated for 600 volts and 5 amperes.

(B) Digital Pre-Timed Solid State Controllers:

The DPT controller shall designate a digital pre-timed controller compatible with NEMA standards, these specifications, the Special Provisions, and the plans.

The Type DPT controller shall be designated with six-position alphanumeric code. The two numbers in the code shall have the following meanings:

DPT18_ - Capacity of up to 18 signal load circuits

DPT40_ - Capacity of up to 40 signal load circuits

The letters in the last position shall have the following meanings:

DPT__S - Computer Supervised Unit

DPT__P - Programmed for Pre-emption

DPT__T - Programmed for Time Base Coordination

DPT__H - Hard Wire Intertie

When the last position has more than one letter, the controller shall have all the functional features defined by each letter.

All the DPT controller units supplied shall be readily programmable for pre-emption and shall include the time base coordination module and programming.

(1) The DPT18 Pre-Timed Controller:

The DPT18 shall meet the following specifications and shall be designed for non-actuated operation of traffic signals having pre-determined cycle lengths, cycle lengths, interval durations, and interval sequences.

The controller shall have three independent cycles with three offsets and two splits per cycle. Cycle lengths shall be front panel adjustable with a front panel cycle-in-effect indicator. The cycle display shall show the local elapsed time, inputs, outputs, and timing values.

The controller shall have 10 signal intervals and 18 independently controlled on/off signal circuit outputs which may be independently programmed for flashing the signal output in a designated interval.

The controller unit for replacement for a type-F electromechanical controller shall be a retrofit back panel 22.5 inches high, 13.0625 inches wide, and 10.3125 deep. The back panel shall house NEMA-type flasher, load switches, and two-channel card rack amplifier. The flasher transfer relays shall be interfaced with a Cinch-Jones type eight-pin socket. The signal load shall be controlled by a 60-ampere tungsten mercury contactor.

(a) Indicators:

Indicators shall include digital read-outs to display all inputs, countdown timing intervals, cycle, split, local master and pre-emption.

(b) Controller Programming:

Program entries shall be front panel programmable without the use of tools or software.

(c) Pre-emption:

Pre-emption functions shall be programmable assignments to include entrance times, track clearance (passage and clearance times), minimum duration protection time, and exit. The programming shall also include detection mode, pedestrian indications operation, delay time, and flash operation.

(d) Vehicle Detection:

The back panel shall include card-rack mounted NEMA-type vehicle detector for two detector channels. Each channel shall input each actuated vehicle signal phase group.

(e) Pedestrian Detection:

The actuated signal phase groups shall have pedestrian actuated movements.

(f) Start-Up and Flash:

The start-up operation and flash operation intervals and timing shall be programmable in the unit.

(g) Control Cabinet for DPT18 T/H:

The control cabinet shall be the type specified on the plans and in the Special Provisions.

The control cabinet shall include the following items: cabinet fan, light, convenience outlet, and police panel.

The following switches shall be included: main-on/off, controller auto on/controller on-flash/controller off-flash, signal lights on/off, and auto/manual.

The following switches shall be mounted inside the police panel: main switch, auto/flash switch, and auto/manual switch, and manual control cord.

(h) Conflict Monitor:

The conflict monitor shall be a cable-connected unit, external, shelf mounted, six channel, NEMA-wired to monitor all functions. All the

equipment housed in the control cabinet shall be installed and removed from the front with ease.

(2) The DPT40 Pre-Timed Controller:

The DPT40 shall be designed for non-actuated operation of traffic signals with pre-determined cycle lengths, interval durations, and interval sequences. The controller unit shall have a minimum of three independent cycles. Each cycle shall have a minimum timing range of 0-255 seconds and interval timing of 0-25.5 seconds, in one-second and one-tenth-second increments. Each cycle length shall be front panel adjustable with a front panel cycle-in-effect indicator. A cycle read-out shall show the time of the local cycle that has elapsed.

Each cycle shall have three offsets and four splits. The four splits (signal interval plans) shall be selected by either a remote interconnect, time switch, or a local detector actuation. The controller unit shall have 31 signal intervals and 40 independently controlled on/off signal circuit outputs which may be independently programmed for flashing the signal output in a designated interval.

(a) Synchronization:

The pre-timed controller unit shall have a manual switch to synchronize itself with an intertie system input, or the controller unit shall be capable of providing a sync-pulse to an intertie system when programmed to be a master controller unit.

(b) Interconnected System:

The controller unit shall be capable of operating with an existing master controller unit with six of 10 functions. The controller unit inputs from a standard-type pre-timed interconnect shall be as follows:

Dial	2	One Input
	3	
Offset	1	
	2	
	3	
Split	1 *	
	2 *	
	3 *	
	4 *	
Flash		
Common		AC neutral

Note:

*Splits 1, 2, 3, and 4 shall be used with a 10-function intertie system only.

Dial 1 shall be in effect when neither the Dial 2 nor the Dial 3 lines are energized.

A master controller unit with direct control by a computer system shall have NEMA-logic level inputs.

(c) Conflict Monitor:

The conflict monitor shall be an external shelf-mounted, 12-channel or larger NEMA cable-connect unit wired to monitor all functions.

(d) Manual Control:

An auto-manual control switch and wiring terminals shall be furnished in the controller cabinet assembly for a momentary contact hand held switch. The auto-manual control switch shall be accessible with a standard police type key. The hand-held manual switch shall be weather-proof on a retractable cable.

Manual operation of the controller shall provide the same color sequence as was programmed for the automatic operation. The duration of all intervals, except the yellow vehicle interval and the red vehicle clearance interval, shall be controlled by operation of the manual switch. Duration of the yellow interval and red clearance interval shall be the minimum time specified to be programmed in the controller unit.

(e) Minimum Timing:

A guaranteed minimum back-up time for each interval, programmed in accordance with the signal plan non-volatile programmable read-only memory, shall be provided as specified on the plans or in the Special Provisions.

(f) Manufacturer Programmed Functions:

The following functions shall be programmed by the manufacturer into the programmable read only memory in accordance with the signal plan specified on the project plans:

(i) Start-up programs:

(ii) Each signal plan and sequence programs:

(iii) Back-up times:

(iv) Remote flash operation programs:

(v) Cycle back-up times:

(vi) Offset back-up times:

(vii) Pre-emption plan and sequence programs:

(viii) Field programmable functions:

The following functions shall be programmable from the front panel by the operator in the field:

Timing Entry;
Cycle Lengths;
Offsets;
Interval Time;
Read-out of cycle, split, and interval;
Read-out of Timing in the PROM; and
Pre-Emption Interval Timing.

(ix) Function Switches:

The following function switches shall be provided:

Lock/Non-Lock - Recall for each detector
Local/Remote selection of cycle, offset, split and plan
Sync/Hold for non-interconnected operation

The programming of the timing entry, cycle, offsets, selectable functions, and phase timing intervals shall be set by entry switches, programming pins or by keyboard entry. Programming shall include digital solid state read-outs of keyboard programmed functions.

(x) Input-Output Connectors:

The signal output connectors shall be compatible with the NEMA four-phase controllers. The controller unit shall use the standard NEMA connectors A and B per NEMA table 13-3, four-phase terminations, and the following tables:

CONNECTOR A			
Pin No.	**Function**	**Pin No.**	**Function**
A	Reserved	f	Det. 1
B	24-Volt DC	g	Det. 5
C	Voltage Monitor	h	Det. 9
D	Sig. Ckt. # 3	i	-
E	Sig. Ckt. # 6	j	Remote Flash
F	Sig. Ckt. # 10	k	Guar. Interval
G	Sig. Ckt. # 13	m	-
H	Sig. Ckt. # 12	n	Signal Plan 2 (Preempt 1)
J	Sig. Ckt. # 11	p	AC +
K	Det. 2	q	Master Sync (Out)
L	Det. 6	r	Spare
M	Det. 10	s	Sig. Ckt. # 1
N	Stop Time	t	Sig. Ckt. # 4
P	Coord. Sync (IN)	u	-
R	External Start	v	-
S	Manual (Interval Advance)	w	Overlap Advance
T	Indicator Lamp Control	x	Free
U	AC -	y	Cycle 2
V	Chassis Gnd	z	Split 4
W	Logic Gnd	AA	Signal Plan 3 (Preempt 2)
X	Flash Logic (1PPS)	BB	O'L Mode
Y	Spare	CC	Spare
Z	Sig. Ckt. # 2	DD	Sig. Ckt. # 7
a	Sig. Ckt. # 5	EE	-
b	Sig. Ckt. # 9	FF	Signal Plan
c	Sig. Ckt. # 8	GG	Split 2
d	-	HH	Cycle 3
e	Sig. Ckt. # 14		

CONNECTOR B			
Pin No.	**Function**	**Pin No.**	**Function**
A	Free Output	f	Spare
B	Flash Cont.	g	Spare
C	Spare	h	Det. 12
D	Sig. Ckt. # 15	i	Det. 11
E	Sig. Ckt. # 16	j	Cycle 4 (Optional Function)
F	Sig. Ckt. # 17	k	-
G	Sig. Ckt. # 24	m	-
H	Sig. Ckt. # 26	n	-
J	Sig. Ckt. # 27	p	Sig. Ckt. # 30
K	-	q	Sig. Ckt. # 31
L	Det. 4	r	-
M	Det. 8	s	Sig. Ckt. # 21
N	Det. 3	t	Spare
P	Det. 7	u	Sig. Ckt. # 40
R	Offset 3	v	-
S	Offset 2	w	Sig. Ckt. # 38
T	-	x	-
U	Offset 1	y	-
V	CMU Stop Time	z	-
W	Split 3	AA	Sig. Ckt. # 29
X	-	BB	Sig. Ckt. # 36
Y	Sig. Ckt. # 18	CC	Sig. Ckt. # 37
Z	Sig. Ckt. # 19	DD	Sig. Ckt. # 34
a	Sig. Ckt. # 20	EE	Sig. Ckt. # 39
b	Sig. Ckt. # 22	FF	Sig. Ckt. # 32
c	Sig. Ckt. # 23	GG	Sig. Ckt. # 35
d	Sig. Ckt. # 25	HH	Sig. Ckt. # 33
e	Sig. Ckt. # 28		

The following inputs shall be in accordance with NEMA:

Stop Timing	Shall have the effect of halting the local percent counter.
Manual Enable	Guaranteed interval inhibit.
Interval Advance (Manual)	Shall step controller through each programmed interval sequentially. Shall operate on trailing edge of pulse. When asserted with stop timing shall provide manual control of all intervals.
Indicator Lamp Control	Shall extinguish all front panel indicators.
External Start	Shall force the controller to the specified starting interval. The normal cycle shall resume immediately upon release of this input.
Detectors, Chassis Ground, and Pre-Emption.	

The following outputs shall be in accordance with NEMA:

Signal Output Circuits:	
Interval 1 On	Shall be active for the duration of interval 1.
Voltage Monitor	Shall be active as long as the controller is providing proper operation.
+ 24 volts DC	
Logic Common	
Master Sync	Shall be active at all times except during the master sync period.
Flash Logic	Shall alternate between true-false logic levels at a one pulse per second repetition rate.

(xi) Pre-Emption:

When specified, a pre-emption program shall be provided in the controller software. The pre-emption program shall be initiated by a non-locking pre-emption call. The pre-emption mode shall have its own timing, including minimum timing and signal plan.

(xii) Electrical Characteristics:

The controller programs provided by the manufacturer shall be permanently stored in a non-volatile memory such that batteries shall not be required to maintain the minimum interval timing, interval sequences, start-on, offsets, cycle and splits, flash on/off, detectors, signal circuits flash, and pre-emption.

(C) Actuated Solid State Digital Controllers:

(1) General:

The actuated solid state digital controller shall be designed for the operation of traffic signals with fully actuated or semi-actuated timing of the traffic signals including operation with auxiliary equipment.

Each actuated controller shall be furnished with the required number of phases, phase sequence, phase timing features, and all other control functions that are specified herein, on the plans, or in the Special Provisions.

(2) DAN-Actuated Controller and Features:

Actuated controllers shall be designated on the plans or Special Provisions with the following designations:

The DAN controller shall designate a digital actuated controller conforming to NEMA Standards, these specifications, the Special Provisions, and the plans.

The number in the alphanumeric code type shall mean the following:

DAN-2 Two-phase controller

DAN-4 The controller shall be capable of operating four phases.

DAN-8 The controller shall be capable of operating eight phases.

(a) Phase Timing:

Each DAN controller unit phase timing or phase module shall include timing periods for each vehicle and pedestrian phase actuated with volume density timing, or non-actuated timing for semi-actuated phase operation. Each phase timing period shall be not less than the minimum required by NEMA.

(b) Controller Pre-Approval:

The DAN controller pre-approval shall be in accordance with current NEMA specifications and these specifications. No additional functions shall be in the DAN controller. Pre-approval tests and evaluations shall be performed by the Department and approved by the Engineer.

(c) Overlap Phases:

Controllers with more than two phases shall be furnished with a NEMA 14-9 overlap program board and driver outputs. The NEMA-type overlaps shall be programmed by the NEMA program board assembly with hard wire jumpers easily accessible inside the controller, or programmed in the controller without the use of tools.

(d) Frame Sizes:

The controller unit frames shall be two-, four-, and eight-phase, not exceeding the NEMA-specified dimensions, except height which shall be 17 inches maximum. Equipment shall be interchangeable in the controller cabinet.

(e) Phase Sequence Operation:

Each phase and associated overlap phases of a single-ring controller shall be sequentially timed as indicated on the plans.

Dual-ring controllers shall be sequentially timed per ring and concurrently timed per non-conflicting phase. Dual-ring controllers shall be programmed for the dual entry mode of operation.

Dual-ring traffic signal controllers that are PROM programmable shall include three PROMS, one installed PROM, and include two spare phase sequence PROMS as follows:

PROM A - Eight-phase, quad left turn operation.

PROM B - Eight-phase, dual left turn ring one operation, sequential ring two operation.

PROM C - Eight-phase sequential operation.

The two spare PROMS shall be identified and packaged for future use.

(f) Controller Input-Output Functions and Connectors:

The controller shall provide all the NEMA input/output functions. The A, B, and C Connectors and their pin assignments shall be the same as shown in Table 13-3 of 1983 NEMA for two-, four-, and eight-phase controller units and their cables.

All A and B connectors and cables shall include specified four- and eight-phase functions, for future use.

Auxiliary connectors shall not be permitted on Type DAN controllers.

(g) Standard Functions:

Standard controller functions specified by NEMA, and as specified in these specifications shall be furnished.

The controller unit functions shall include NEMA TS-1, Sections 13 and 14.

The standard functions shall be the NEMA-specified features on a per phase, per ring, and per unit basis.

(h) Pre-Programmable Guaranteed Minimum Clearance Timing:

All controllers shall have a guaranteed minimum clearance timing program and shall be programmed as follows:

(i) Guaranteed yellow change interval: three seconds

(ii) Guaranteed pedestrian clearance interval: five seconds
The controller shall have the capability to permit exclusive pedestrian phase when required.

(i) Pre-Programmable Backup Timing:

All controllers with a backup timing PROM capability shall be programmed for the type of phase movement for the minimum times as follows:

Any Vehicle and Pedestrian Phase Movement (Non-Actuated)	
Interval	**Time in Seconds**
Minimum Green	25
Walk (Solid)	7
Ped Clearance (Flashing)	10
Yellow Change	4
Red Clearance	2

Any Vehicle and Pedestrian Phase Movement (Actuated)	
Interval	**Time in Seconds**
Initial Green	10
Vehicle Extension (Passage)	3
MAX I	25
MAX II	30
Walk (Solid)	7
Red Clearance (Flashing)	10
Detector Memory	ON
Recall Mode	PED.

Any Vehicle Exclusive Turning Phase Movement	
Interval	**Time in Seconds**
Initial Green	8
Vehicle Extension (Passage)	2
MAX I	20
MAX II	25
Yellow Change	4
Red Clearance	2
Detector Memory	ON
Recall Mode	Vehicle

Any required change or additions by the manufacturer to these time values shall be cleared through the Engineer before delivery of the controller assembly.

(3) The MPS Controller & Features:

The MPS controller shall designate a digital microprocessor controller that conforms to all the DAN controller specifications, and shall include special programmable applications as specified in these specifications, and the plans.

(a) MPS Controller Minimum Phase Requirements:

The MPS Controller shall be a four-phase or eight-phase dual ring operation or twelve-phase dual or three ring operation as required in the plans.

The type of MPS controller shall be designated by the special program applications required.

The last letters shall designate the following:

MPS-SI	Computer Supervised Unit - Interconnected
MPS-SD	Computer Supervised Unit - Dial Up
MPS-P	Programmed for Pre-Emption
MPS-T	Programmed for Time Base Coordination
MPS-C	Programmed for TM Coordination - Traffic Actuated Coordination
MPS-M	Arterial Master Controller - Interconnected
MPS-SF	Programmed for any additional Special Functions per Special Provisions.

The MPS controller shall include the following features:

(i) Each MPS controller shall include the programming and module for Time Base Coordination with a front panel "D" connector, or auxiliary connector for all non-NEMA functions;

(ii) All non-NEMA input/output functions shall be contained in a system or "D" connector only;

(iii) Each MPS controller shall include the printer interface and port. The printer interface shall permit printout of all controller, coordinator, and pre-emptor operator entered data;

(iv) The "D" Connector shall be located on the front panel; and

(v) The MPS controller main frame shall be readily compatible for MPS-P pre-emptor programming.

(b) MPS Controller Pre-Approval:

In addition to meeting the DAN controller pre-approval requirements, the Department will require each MPS controller model and special program type to be tested and evaluated on a program-by-program basis before approval by the Engineer. Each approval will be limited to each type of program required by the Department, not by manufacturer or model. The number of manufacturers pre-approved by the Department may be limited for each type of program the Department requires.

Existing Department approved controller programs shall be limited to the manufacturer's program version and model currently in operation for a specified geographic area as required by the Engineer.

Approval of a MPS arterial or interconnected supervised controller unit shall be limited to the Department's operating computer management software and hardware.

(c) MPS Twelve-Phase Controller:

The twelve-phase controller shall meet all DAN controller specifications plus the following functions:

(i) All non-NEMA functions and phases shall be contained in a "D" connector or auxiliary connector on the front panel;

(ii) The controller shall include twelve phases with both vehicle and pedestrian timing;

(iii) The controller shall have allocation of phases to be operated in a special programmable concurrent phase or co-phase mode. Up to six phases may be used as co-phases. The co-phases shall be capable of being implemented to create additional rings. The co-phase timing parameters shall be entered from the front panel;

(iv) The controller shall contain two additional overlaps to the four NEMA overlaps;

(v) The controller shall include Time Base Coordination and three pre-emption programs; and

(vi) The controller shall accept up to 16 detector inputs.

(d) MPS - Coordination Programming Pre-Approval:

The MPS-S computer supervised controller and the MPS-M arterial master controller for systems shall be pre-approved by the Engineer per the Department's computer hardware and software requirements.

The MPS-C TM coordination and MPS-T time base coordination shall be pre-approved by the Engineer per the Department's system requirements. Each manufacturer's unit shall be readily interchangeable within the same model line.

(e) MPS-T Time Base Coordination Program:

(1) The MPS-T program for time base coordination shall be included in each MPS controller unit.

The MPS-T program shall consist of the hardware, software, and cabinet wiring to provide coordinated traffic flow without the use of interconnect cables between controller units in a dedicated geographic area. The MPS-T program shall be supervised by its own clock, which will monitor the program's memory so as to implement routine time of day, day of week, and week of year programs; as well as automatic daylight savings selection.

(2) The MPS-T controller program shall include the following functions:

(i) Shall be capable of being system interfaced (intertie or dial-up) for a program monitoring and data down-loading and system data up-loading. The data down-loading and clock updating shall also be accomplished by a hand-held device;

(ii) The coordination programming shall include the following phase timing options: The MPS-T Controller shall have a coordination system "D" connector. The system connector shall function as input/output port and auxiliary output connector. All outputs shall be NEMA compatible; and

(iii) The MPS-T Controller shall provide for all time base coordination, user program data input, and the status read-outs, including cycle countdown and program data display, on the front panel.

(f) MPS-T Controller Cabinet Wiring:

The following cabinet wiring functions shall be included with the MPS-T controller cabinet assembly:

(i) The cabinet shall be wired for call to non-actuated mode I for the highway and mode II for cross street, unless otherwise specified;

(ii) The inside cabinet switch panel shall include a switch for coordination, and free run modes of the coordinator program. The remote free input shall be wired to a cabinet terminal tie point; and

(iii) Two auxiliary time of day (24 hour) outputs shall be wired in the cabinet to program special functions via the coordination system "D" connector.

(g) MPS- Pre-Emption Programming:

The MPS Controller shall include all the required hardware and CPU software so as to readily accept the addition of a MPS-P program.

The MPS-P pre-emptor programmed controller unit shall be pre-approved by the Engineer as per the Department's requirements for any geographic area or system. Each manufacturer's unit shall be readily interchangeable within the same model line.

The MPS-P pre-emptor program shall include all required hardware and programming with an input/output connector cable interface. The removal of the pre-emption module shall not interfere with the normal operation of the controller unit.

The MPS-P controller shall have the pre-emption user program data inputs and status read-outs, including pre-emption intervals and program data, displayed on the front panel.

The following is an outline for a MPS-P program scheme. Each MPS-P program shall be evaluated by this scheme.

(i) Pre-emptor Intervals:

The pre-emptor shall control intervals by ring. Before the initiation of pre-emption, a delay input interval must be completed. If the delay is released before timing out, the pre-emptor will not initiate time.

During pre-emptor timing any higher priority pre-emption input will override the active pre-emptor mode.

(ii) Interval Programs:

The following interval functions and sequence per ring shall be programmed in the pre-emptor module.

Interval 1: The minimum guaranteed green interval.

The effective start time for this interval is when the phase that is timing enters green. Therefore, if the phase was in green longer than the interval programmed time prior to initiation of pre-emption, the pre-emptor will advance to interval 3.

Interval 2: The minimum guaranteed green-pedestrian clearance interval.

The effective start time for this interval is when the phase that is timing enters pedestrian clearance. Therefore, if the phase was in pedestrian clearance longer then the interval programmed time prior to initiation of pre-emption, the pre-emptor will advance to interval 3.

Interval 3: The minimum guaranteed phase yellow clearance interval.

The effective start time for this interval is when the phase that is timing enters yellow clearance. Therefore, if the phase was in yellow clearance longer than the interval programmed time prior to initiation of pre-emption, the pre-emptor will advance to interval 4.

This interval will only be in effect if pre-emption was initiated during green or yellow. Pre-emption will terminate the green or yellow phase.

Interval 4: The minimum guaranteed overlap yellow clearance interval.

Any overlap is assigned to one ring that is timing during entry into pre-emption. The overlap will terminate when that ring starts interval.

The effective start time for this interval is when overlaps go into yellow clearance. If the overlaps have been in yellow clearance longer than the interval programmed time prior to the initiation of pre-empt, the pre-emptor will advance to interval 5.

Interval 5: The minimum guaranteed overlap all-red clearance interval.

The effective start time for this interval is when the overlaps that are going to terminate and the phase that is timing are in red. This interval will stay in effect until all the overlaps that are going to terminate, and the phase that is timing has been in red for the programmed all-red time. The pre-emptor then will advance to interval 6.

If there is no track clearance phase assigned to a ring, that ring will advance to interval 9.

Interval 6: The track clearance green interval.

This interval will time the assigned track clearance green programmed time, and upon completion, the ring will advance to interval 7.

Interval 7: The track clearance yellow interval.

This interval will time the assigned track clearance yellow programmed time. When the timing is complete, the ring will advance to interval 8.

Interval 8: The track clearance all red interval.

This interval will time the assigned track clearance all red programmed time. When the timing is complete, the ring will advance to interval 9.

Interval 9: The hold/lock interval.

When both rings of the pre-emptor sequence have reached interval 9, the pre-emptor will be advanced to interval A.

Interval A: The duration passage interval.

This interval will time the completion of the programmed duration time. The duration time will start timing when the pre-emption sequence is started. Interval A will insure that the pre-emption sequence will not terminate until programmed time after initiation of pre-emption, regardless of the phases and intervals in effect during initiation of pre-emption or the timing of intervals preceding interval A.

The phase assigned for each ring shall operate as a hold phase. The options of "ped indications active" and "hold flash" take effect during this interval.

Interval B: The hold/passage interval.

The hold time will start timing when pre-emption interval A starts. Interval B will insure a minimum time in the passage movement before pre-emption will be permitted to terminate. The interval will terminate only when the programmed time is complete and the pre-emption input is non-active, after which the interval will be set to C.

The hold phases, "ped indications active" and "hold flash" shall be applied during interval B.

Interval C: The hold/passage yellow clearance interval.

At the completion of the hold/passage interval, the hold clearance yellow will time unless:

(1) There are no exit phases. The pre-emptor will be non-active, and exit as soon as interval B is complete.

(2) The pre-empt call returns active. The pre-emptor will go back to interval B.

When the hold/passage yellow clearance timing is complete, the interval will advance to interval D.

Interval D: The hold/clearance all-red clearance interval.

If the pre-emption call returns, the pre-emptor will go back to interval B.

When the hold/passage all red clearance timing is complete, the interval will advance to interval E.

Interval E: The exit lock interval for the pre-emptor.

When both pre-emption rings get to interval E, the pre-emptor will exit the pre-emption sequence.

(iii)Pre-emptor Flash:

The Type MPS controller pre-emption module flash can be initiated in the following ways:

(a) Hold Flash;
(b) Power up with pre-emption;
(c) External start with pre-emption;
(d) Sum check bad;
(e) Power up/external start with illegal phases; and
(f) Illegal controller software valve.

The pre-emptor flash control output shall be true (low) during pre-emptor flash.

The controller signal output drivers will flash red if they are not assigned as a hold phase. The output shall flash yellow if assigned as a hold phase.

The required preemption intervals shall be programmed for single track or dual track clearance as shown on the plans.

734-2.03 Control Cabinets:

(A) General:

The control cabinets covered in this section shall be used to house all traffic pre-timed and actuated signal controller assemblies and shall

include intersection controller cabinets and auxiliary controller cabinets. The cabinets shall be wired for all additional future phases and all associated equipment for the future phases shall be furnished and installed.

Cabinets shall be wired and tested by the controller manufacturer or a representative designated by the controller manufacturer. The cabinet wiring shall be covered by the controller manufacturer's warranty.

The following cabinet types shall be supplied when specified on the plans. The cabinets shall be constructed according to the Traffic Signal and Highway Lighting Standard Drawings:

Type I Pedestal Base Cabinet

Type I Controller Cabinet

Type II Controller Cabinet

Type III Controller Cabinet

Type IV Controller Cabinet

Type V Controller Cabinet

Auxiliary controller cabinets shall be either a Type I controller cabinet for pole mounting or a Type II Load Center Cabinet for foundation mounting.

The controller cabinet housings shall be of a NEMA 3 weather resistant construction. The steel cabinet housing and accessories shall be treated on the inside and outside with one coat of primer paint and painted with two coats of aluminum paint in accordance with Section 1002 of the specifications. Cabinets shall have continuous welded seams on all outside seams.

The steel fabricated cabinet housings shall be constructed with No. 14 copper bearing sheet steel.

The aluminum fabricated cabinet housings shall be constructed with No. 10 gage welded sheet aluminum. The cabinet finish shall be clean and not painted.

(B) Hardware:

(1) Doors:

The doors shall have a neoprene gasket around the perimeters of each door frame. The door hinge pins shall be stainless steel. The main

controller cabinet door, except the Type I, shall have a two-position steel-bar type door stop.

The main doors of the Types III, IV, and V controller cabinets shall be secured by a three-point locking device.

(2) Locks:

The main doors of controller cabinets shall have a standard traffic signal self-locking tumbler lock. The three-point door latch cam shall be steel.

The pedestal base cabinet doors and the police panel doors shall have a standard police-type lock. The police-type lock key shaft shall be a minimum of 1-3/4 inch in length.

A minimum of two keys per lock shall be furnished with each cabinet.

(3) Shelves:

Each controller cabinet shall be furnished with metal shelves capable of supporting all shelf mounted equipment without bending or sagging.

The shelves shall not sag or restrict the free flow of air. The cabinets shall contain adjustable support brackets. For NEMA controllers the following shelf heights shall be furnished with the delivered cabinet:

(a) A minimum shelf height of 14 inches shall be provided for two-phase controllers; and

(b) A minimum shelf height of 15 inches shall be provided for four-phase and eight-phase NEMA controllers, and pre-timed controllers.

(C) Cabinet Accessories:

The following accessories shall be provided with each controller cabinet as specified herein:

(1) Cabinet Light:

The Types II and III controller cabinets shall contain a minimum 15-inch fluorescent light fixture and lamp. The Types IV and V controller cabinets shall contain a minimum 18-inch fluorescent light fixture and lamp. The fixture shall be mounted on the inside top of the cabinet near the front edge of the roof so that the front panels of the control equipment will be illuminated.

A door-actuated, refrigerator-type, normally closed, durable push-button type switch shall automatically turn the light fixture on and off when the door is opened and closed.

(2) Switches:

The switches described in this section shall be provided for all solid state digital controller cabinets. Each switch shall be a commercial grade switch properly rated for the circuits they control. Each switch shall be individually labeled to identify its function. The label shall be an engraved laminated plastic legend plate or a permanently printed metallic legend plate.

The following switches shall be mounted on the cabinet switch panel inside the controller cabinet housing:

(a) Indicator Lamp Control: A door actuated switch that shall operate with any controller unit which activates the controller indicator lamps;

(b) Auto/Flash Switch: A toggle switch to transfer to flashing operation. During the flash operation the AC power shall be disconnected from the controller;

(c) Detector Call Test Switches (including Pre-Timed-Cabinets): A test switch shall be furnished to simulate a vehicle and pedestrian actuation. Each switch shall be a momentary contact push button. The metering controller shall have test switches for each detector input shown on the plans. Each switch shall be labeled to identify its function and phase;

(d) Pre-emptor Switch: When a traffic control pre-emptor is specified on the plans, it shall be controlled by a two-position toggle switch. The "Test" position shall manually turn on the pre-emption operation. The "Auto" position shall be for automatic external control of the pre-emptor;

(e) Stop Time Switch: A separate two-position stop time toggle switch shall be provided to permit stop timing/automatic mode of the controller's stop time function. The two positions shall be labeled "stop time - auto". When required, other special function switches shall be furnished. Such switches shall be of the proper voltage and current rating to perform the function as specified. The following switches shall be mounted in the police panel;

(f) Main Switch: This shall be the main on/off switch to control the AC power to the signal controller assembly. The switch shall be properly sized for the amperage of the equipment;

(g) Auto/Flash Switch: shall be a toggle switch to transfer from automatic control to flashing operation. During the flash operation the AC power shall be maintained to the controller; and

(h) Photo-Off-Manual Switch: Lighting contactors shall be controlled by a three-position double-pole, double-throw switch. The "Photo" position shall place the contactor under the control of the photoelectric cell unit. The "Off" position shall disconnect the contactor's coil from the photoelectric control. The "Manual" position shall activate the contactor and turn on the intersection lighting.

(3) Convenience Outlet:

A 120-volt AC, 15-Amp. NEMA 5-15 G.F.I. convenience duplex outlet shall be mounted in each cabinet for energizing test equipment or tools. The outlet shall be fuse protected.

(D) Cabinet Ventilation Equipment:

(1) Cabinet Fan and Filters:

Controller cabinets containing solid state electronic equipment shall be ventilated by means of a 120-volt AC, 60-hertz, tube-axial compact type fan. The fan's free delivery air flow shall be not less than 100 cubic feet per minute.

The fan housing shall be approximately 4 inches square by 1-1/2 inches deep.

The magnetic field of the fan motor shall not affect the performance of the control equipment.

The fan bearings shall operate freely within the environmental standards specified herein.

The fan unit shall not crack, creep, warp, or have bearing failure within a five-year rated duty cycle. The maximum noise level shall be 40 decibels. The fan unit shall be corrosion resistant.

The cabinet fan shall be controlled by an adjustable snap action thermostat. The thermostat's turn-on setting shall be adjustable from 90 to 120 degrees F. The fan shall run until the cabinet temperature decreases to approximately 20 degrees F below the turn-on temperature setting. The fan shall be fused.

The cabinet fan assembly shall be mounted either inside the control cabinet or inside a rainproof housing on top of the control cabinet.

The cabinet shall have louvered air inlets in the lower portion of the main door. A standard furnace filter shall be mounted behind all the louvered air inlets.

The air outlets shall be screened on the exhaust side of the fan unit. The cabinet shall have a dust resistant air outlet baffle well secured and removable in the top of the cabinet.

Auxiliary cabinets containing solid state electronic equipment shall use fan units with a free delivery air flow of not less than 100 cubic feet per minute. The fan unit shall be approximately 3-1/2 inches square. All other fan characteristics shall be as described above in this section.

(E) Electrical Devices:

(1) Legend Plates:

An engraved laminated plastic legend plate or a permanently printed metallic legend plate shall be provided inside the control cabinet for each control device, connector cable, connector, and fuse mounted in the cabinet. Each control device shall be labeled to identify the type of device and its connector number. Each fuse shall be labeled to identify its rating and circuit function.

(2) Power Panel:

The power supplied to the controller cabinet shall be 120-volt AC, two-wire, 60-hertz, single-phase service unless otherwise specified.

The power leg to the controller and the signal load circuits shall be protected by a single-pole, 120-volt AC, circuit breaker. The breaker shall have a 10,000 ampere interruption rating, a trip indicator, and shall be the bolt-on type. The ampere rating shall be properly sized for the traffic signal intersection's load.

The neutral service leg shall be connected to the AC neutral buss.

The 120-volt AC intersection lighting control circuit, and the convenience outlet shall not be connected to the same service leg to which the controller's power supply is connected.

The lighting load shall be 240-volt AC unless otherwise specified.

(3) Radio Interference Suppressor:

Each control cabinet shall be equipped with a single radio interference suppressor (RIS) of sufficient ampere rating to handle the load requirements. The RIS shall be installed at the input power point. It shall minimize interference in both the broadcast and the aircraft frequencies, and shall provide a minimum attenuation of 50 decibels

over a frequency range of from 200 kilohertz to 75 megahertz, when used in connection with normal installations.

The RIS shall be hermetically sealed in a substantial metal case which shall be filled with a suitable insulating compound. The terminals shall be nickel-plated 10/24 brass studs of sufficient external length to provide space to connect on No. 8 AWG wires, and shall be so mounted that they cannot be turned in the case. Ungrounded terminals shall be properly insulated from each other, and shall maintain a surface leakage distance of not less than 1/4 inch between any exposed current conductor and any other metallic parts. The terminals shall have an insulation factor of 100-200 megohms dependent upon external circuit conditions. The RIS shall not be rated less than 50 amperes.

The RIS shall be designed for operation on 115-volt AC ± 10 percent, 60-hertz., single-phase circuits, and shall meet the standards of UL and the Radio Manufacturers Association.

(4) Surge Protector:

Each controller cabinet shall be provided with a 350-volt surge protector at the input power point. The surge protector shall reduce the effects of power line voltage transients and shall have ratings as follows:

Impulse Breakdown	Less than 1,000 volts in less than 0.1 microseconds at 10 kilovolts per microsecond
Standby Current	Less than 1.0 milliampere
Striking Voltage	350 volts D.C.

Shall be capable of withstanding 15 pulses of peak current each of which will rise in 8.0 microseconds to one-half the peak voltage at three-minute intervals. The peak current rating shall be 20,000 amperes.

(5) Inductive Suppressors:

Each 120-volt AC circuit that serves an inductive device, such as a fan motor, cabinet light, or a mechanical relay, shall have a suppressor to protect the controller's solid state devices from excessive voltage surges. Such suppressors shall be in addition to the surge protector at the main input power point.

(F) Cabinet Wiring Standards:

(1) Conductors:

All conductors used in controller cabinet wiring shall be No. 22 or larger, with a minimum of 19 copper strands. Conductors shall conform to Military Specification MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon-jacketed polyvinyl chloride or shall be irradiated cross-link polyvinyl chloride, polyhalocarbon, or polychlor-alkene.

(2) Lead-in Wires and Cable:

Lead-in wires, from the loop detector field terminals in the cabinet to the amplifier unit inside the cabinet, shall conform to one of the following:

A twisted pair of No. 22, or larger, conductors.

A cable containing two No. 22, or larger, conductors with each conductor insulated with either (1) a minimum of 10 mils of polyvinyl chloride and 2 mils of nylon, or (2) a minimum of 14 mils of polyethylene or polypropylene. The conductors shall be twisted pairs with three to six turns per foot. The cable shall be provided with a polyethylene or polyvinyl chloride outer jacket with a minimum thickness of 20 mils, or with a chrome vinyl outer jacket with a minimum thickness of 25 mils.

All conductors used in controller cabinet wiring shall conform to the following color code requirements:

The AC common conductors shall be identified by a continuous white or natural gray.

The chassis ground conductors shall be identified by a continuous green color with one or more yellow stripes.

The non-grounded conductors shall be identified by any color not specified above.

(3) Load Switch and Flasher Wiring:

Each of the load switch outputs (120-volt AC) and the flash transfer relay load base terminals shall be hard-wired with a minimum No. 14 copper conductor with a 90 degrees C rated jacket, or No. 16 copper conductor with a 105 degrees C rated jacket.

The 120-volt AC load switch and flash relay terminals shall be soldered to each base terminal.

(4) Signal Load Switch Buss:

The AC+ signal load switch buss shall be controlled by a signal-pole 120-volt AC mercury contactor or an auxiliary control relay. The minimum contactor size per switch buss shall be 30 amperes.

(5) Signal Load Panels:

All load switches, flashers, and flash transfer relays shall be mounted on a load bay panel or back panel assembly of the appropriate size.

Each load switch input from the controller shall be programmable on the back panel by use of removable jumpers to facilitate possible redesignation of output assignments due to future phasing requirements.

Detector amplifier modules may be mounted on the panel in lieu of a detector rack.

The signal load panel or back plane panel shall be easily removable from the cabinet for repair in the field.

All the control hardware and wiring shall be mounted and installed so as to permit the main back panel to be released and dropped for the service repairs in less than 10 minutes.

The load bay or back plane panel shall be wired to include all future signal phases and operations shown on the plans.

Printed circuit board type back panels shall only contain 0- to 24-volt DC circuits. No 120-volt AC circuits will be allowed.

(6) Pre-emption:

When specified, the controller cabinet shall include the cabinet wiring provisions for a pre-emptor controller unit and its cables.

(G) Meter Pedestal Cabinet:

Meter pedestal cabinets shall be furnished and installed in accordance with the project plans and specifications. The cabinet shall be UL listed.

The cabinet shall be 12 gage steel of tamperproof construction with piano-hinged doors and provisions for padlocks. The top and front covers of the cabinet shall be 16 gage steel.

The cabinet shall be treated on the inside and outside with one coat of primer paint and painted with two coats of aluminum paint, conforming to the requirements of Section 1002 of the specifications. The cabinet shall be completely wired with copper conductors to include the required circuit breakers and lighting contactors and shall be wired and equipped to handle electrical service loads as detailed on the project plans.

The service pull section shall be 4-1/2 inches deep and shall be located in back of the cabinet. An access opening in the cabinet shall be provided at the bottom of the service pull section.

Each cabinet shall have a detachable pad mount sleeve for easy installation in concrete which can be bolted to the base of the pedestal.

Electrical service shall be 120/240-volt 60-hertz, three-wire service.

(H) Cabinet-Mounted Service Enclosure:

The cabinet-mounted service enclosure shall be mounted on the back of control or load-center cabinets to provide a combination of metered and unmetered service for traffic signals and highway lighting, respectively. The service enclosure shall provide for both metered and unmetered load circuits. The enclosure shall be rated for 100-ampere continuous service and shall comply with the requirements of the serving utility company.

The cabinet-mounted service enclosure shall be fabricated from 14 gage zinc-coated steel with tamperproof construction. The enclosure shall be a NEMA 3R rainproof type with provisions for padlocks.

The enclosure shall have factory installed breakers, sockets and other components and shall be U.L. listed. The installed conductors shall be copper of the size and type to conform to the NEC and U.L. requirements.

The enclosure shall be finished with one coat of primer paint and two coats of aluminum paint conforming to the requirements of Section 1002 of the specifications.

(I) Cabinet Foundations:

Concrete for cabinet foundations shall be 3,000-pound per square inch Class S concrete.

734-2.04 Auxiliary Control Equipment:

The auxiliary equipment described in this section shall be supplied and installed as required inside the controller cabinet.

All auxiliary equipment shall conform to current published NEMA Standards pertaining to that device.

(A) Flasher Control Assembly:

The flasher control equipment shall consist of a complete electrical assembly which shall provide flashing traffic signals by enabling flash relays when the auto/flash switch or conflict monitor is activated. The relays shall be the flash load relay type as specified herein.

(B) Solid State Flashers:

The flasher unit shall be a solid state NEMA-type flasher. All flashers for signalized intersections, pole flashers, and overhead flashers, shall be the dual circuit type.

All the flashers shall be constructed of replaceable, molded relay modules. Each relay module shall have the specified ampere capacity and shall operate with zero point switching.

The flasher shall turn on within 5 degrees of the zero voltage point of the line sinusoid and shall turn off within 5 degrees of the zero current point of the line sinusoid. The flashing rate shall be 55 to 60 flashes per minute with a 50 percent duty cycle.

Solid state flashers shall be one of the following types:

Type 1 20 amperes per circuit, single circuit

Type 2 20 amperes per circuit, dual circuit

The flashers shall interconnect with a six-pin Cinch-Jones, S-406-SB socket. The flasher shall either have a support bracket or shall be mounted in a rack frame.

(C) Solid State Load Switches:

Load switches shall meet the requirements of NEMA for three-circuit load switches.

Each load switch shall contain three individually replaceable, solid state relay modules. Each relay module shall utilize optical isolation between the input and the output. The relay module shall have the following functions and terminal assignments:

Terminal	Function
1	120 volt AC Output
2	120 volt AC Line
3	+12 to 28 volts DC
4	Sequence Input (Ground)

Each panel of load switches shall either be rack mounted or shall have a switch support bracket extending across the entire length of the switch panel.

The load switch unit shall have three indicators to designate when the AC output circuits are activated. Each indicator shall monitor the outputs and shall be labeled top to bottom "R" Red, "Y" Yellow, and "G" Green, on the front panel of the load switch unit.

(D) Flash Load Relays:

Flash load relays shall be for the purpose of providing special circuitry or operational requirements. The relays shall be the double-pole, double-throw type.

Flash relays shall interconnect with a Cinch-Jones type eight-pin socket or an approved equal. The relay shall be covered with a clear dust cover which shall be secured to the relay base with a fastening device.

The relay contact points shall be of fine silver or silver alloy, or a superior alternate material, and shall be capable of carrying a load of 20 amperes per contact unless otherwise specified at 120 volts AC.

The relay shall show no failure while making, carrying, and breaking a 10-ampere, 120-volt, traffic signal lamp load through 10,000 cycles at the rate of 10 cycles per minute and a 50 percent duty cycle. Each relay shall be capable of making, breaking, and carrying all the current for a 1,000-watt tungsten lamp load without burning, pitting, or otherwise failing for at least one million operations.

The relay shall be electrically and mechanically operative after a momentary current of 100 amperes at 120 volts is applied to the set of closed contacts at least five times with a minimum of two minutes between applications of current. The relay shall not break down or flash over while carrying a load of 10 amperes at 120 volts for at least 50 cycles at the rate of five cycles per minute. The duty cycle shall be 50 percent on and 50 percent off.

The relay shall withstand 1,500 volts at 60 hertz between insulated parts and between current carrying parts and grounded or non-current carrying parts.

(E) Auxiliary Control Relays:

These types of relays shall be utilized in circuits to provide special operations.

Auxiliary control relays shall have a pin-type connector on the base. The relay shall be removable without the use of tools.

The relay shall be covered with a removable dust cover. The relay coil shall be rated at 120-volts AC, 28-volts AC/DC, or 12-volts AC/DC as required. The contacts shall be single-pole or double-pole. The number of contacts shall be as required by the relay's operational functions. The contacts shall be properly rated for the circuit load and shall be constructed of gold- and/or silver-plated material.

(F) Conflict Monitors:

The conflict monitor shall conform to the current NEMA specifications.

Fully programmable monitors shall be programmed with soldered wire jumpers on a NEMA interchangeable programming card. Jumpered channels shall represent nonconflicting phases. Non-jumpered channels shall be in conflict with any other channel.

When a malfunctioning monitor is replaced in the field, the replacement monitor shall be field programmable without the use of tools.

The jumper numerical sequence shall be standard NEMA matrix.

The monitor shall have an active indicator for each channel.

(G) Detector Amplifiers:

(1) General:

The correct type and quantity of detector amplifiers shall be furnished as specified herein, as required on the plans. Unless otherwise specified, all detector amplifiers shall be rack mounted or mounted on a load bay panel with support brackets. Each rack position shall be labeled.

Each detector card shall be the edge connected type. The detector edge connector shall be a 44-pin double read-out contact. The connector shall have 0.128-inch diameter mounting holes on each end, MIL-M-14 insulation material, and MIL-C-21097 contacts.

The edge connector terminals, for the specified type of detector amplifier, shall be wired as specified herein. All of the detector channel inputs and outputs, including those channels specified for future use, shall be wired from the mounting rack to the tie points and the field terminals of the controller cabinet.

Each amplifier rack assembly shall include one power supply card per each set of four detector amplifier modules. The required number of power supply cards shall be furnished with each rack assembly which shall include the quantity of power supply cards for future phases shown on the plans and one spare edge connector.

The required quantity of amplifier modules, including those required for future phases shown on the plans, and one spare edge connector shall be furnished with each control cabinet assembly.

The amplifier rack positions shall be mechanically and electrically interchangeable such that amplifier modules of different manufacturers can be connected into any amplifier module positions. The rack spacing shall be for NEMA 2.31-inch wide front panels on all card rack units.

(2) Detector Amplifier Power Supply:

A rack-mounted 24-volt DC power supply shall be furnished with each controller cabinet assembly with more than two amplifier modules. Each detector amplifier module shall have a 24-volt DC power supply. The power supply shall have four power outputs each fused and rated at 300

milliamps and 24 volts DC and a maximum ripple voltage of 2.2 volts peak to peak. All 120-volt AC circuits shall have fused inputs.

The power supply PIN numbers and functions shall be as designated in the following table:

Standard Input and Output Functions for Vehicle Detection Assembly			
Power Supply			
Pin No.	**Function**	**Pin No.**	**Function**
A	Output Logic Ground	1	(Redundant Side)
B	Output 1 (+24-volt DC)	2	
C		3	
D		4	
E		5	
F		6	
H		7	
J		8	
K		9	
L	Chassis Ground	10	
M	115-volt AC (-)	11	
N	115-volt AC (+)	12	
P		13	
R		14	
S		15	
T		16	
U	Output 3 (+24-volt DC)	17	
V	Output 4 (+24-volt DC)	18	
W		19	
X		20	
Y		21	
Z		22	

(3) Loop Detector Amplifiers:

(a) General Requirements:

There shall be one amplifier channel per detector, except for the 6- by 6-foot detectors, unless otherwise specified.

The amplifier unit shall utilize digital solid state circuitry. The detection, frequency counting, and inductance measuring circuitry shall utilize crystal controlled MOS-LSI microelectronic circuits.

The loop detector amplifiers shall detect all licensed motor vehicles when using the loop configuration shown on the plans. The loop amplifiers shall be operational when using up to 1,000 feet of lead-in cable for a 6 by 6-foot, three-turn, loop. Each loop detector amplifier shall detect vehicles at speeds of zero to 80 miles per hour using loop configurations ranging from: 6 by 6 feet - two-turn, 6 by 50 feet - one-turn, 6 by 70 feet - one-turn; up to 6 by 100 feet - one-turn loops. The

smaller size 6 by 6-foot loop sensors shall be capable of being connected to the amplifier in series and/or parallel as required.

(b) Loop Detector:

The loop detector amplifier unit shall contain two to four channels per unit.

The following types of loop detector card rack units shall be used to identify the number of detector channels and timing functions for each card:

LCR-2	Loop detector card unit with two channels.
LCR-2T	Loop detector card unit with two channels having timing functions.
LCR-4	Loop detector card unit with four channels.
LCR-4T	Loop detector card unit with four channels having functions.

No single channel amplifier shall be utilized. All loop detector card units shall be mechanically and electrically interchangeable with other card units of the same type and function from different manufacturers.

The loop modules and loop modules with timing function PIN numbers and functions shall be as designated in the following table:

Standard Input and Output Functions for Vehicle Detection Assembly			
Loop Module 2 or 4 Channel			
Pin No.	**Function**	**Pin No.**	**Function**
A	Logic Ground	1	Channel 1 Green
B	+24-volt DC IN	2	Channel 2 Green
C		3	Channel 3 Green
D	Loop 1 Twisted	4	
E	Loop 1 Pair	5	
F	Output 1 (+)	6	
H	Output 1 (-)	7	
J	Loop 2 Twisted	8	
K	Loop 2 Pair	9	
L	Chassis	10	Channel 4 Green
M		11	
N		12	
P	Loop 3 Twisted	13	
R	Loop 3 Pair	14	
S	Output 3 (+)	15	
T	Output 3 (-)	16	
U	Loop 4 Twisted	17	
V	Loop 4 Pair	18	
W	Output 2 (+)	19	
X	Output 2 (-)	20	
Y	Output 4 (+)	21	
Z	Output 4 (-)	22	

Standard loop detector racks for amplifiers not requiring timing functions shall still be wired for possible future use of timing functions (pins 1, 2, 3, and 10). The wires from these pins shall be tied to spare terminal block tie points in the cabinet.

Polarization keys shall be located at three positions:

(i) Between B/2 and C/3

(ii) Between M/H and N/12

(iii) Between E/5 and F/6

(c) Amplifier Requirements:

Each amplifier channel shall have a front panel mounted indicator to provide a visual indication of each vehicle detection. The indicator shall be visible in bright sunlight from 3 feet directly in front of the amplifier.

The amplifier shall operate in compliance with all the requirements herein specified when connected to an inductance loop plus lead-in, of from 50 to 500 microhenries with a loop Q parameter as low as 5.0 at the amplifier's operating frequency.

Each channel's call output shall be an optically isolated solid state type. Each amplifier channel shall conform to the following requirements:

(i) Amplifier Tuning: Each channel shall be manual or self-tuning and shall be fully operational within three minutes after power up. After a power interruption, the channel shall automatically return to normal operation;

(ii) Tracking: Each channel's circuits shall be designed so that changes due to environmental drift and applied power fluctuations shall not cause an actuation. Self-tracking shall be capable of compensating for environmental changes of up to 0.001 percent per second. The requirement must be met within two hours after initial power up. The channel shall be capable of normal operation as the input inductance is changed ± 5.0 percent from the quiescent turning point regardless of initial circuit drift; and

(iii) Detection Modes: Each channel shall have a mode selection switch on the front panel which shall permit the selection of either the presence mode or the pulse mode of operation. In the pulse mode, the pulse width shall be 100 milliseconds unless otherwise specified. Each module shall have an off switch position for disabling unused channels.

(d) Special Timing Functions:

The following special timing functions shall be furnished only when specified on the plans or in the Special Provisions.

(i) Delay Timing Function: This timing function shall delay the call output up to 15 seconds after the vehicle enters the loop sensor. The timer shall be adjustable, from 0 to 15 seconds, into no more than 1.0-second increments;

(ii) Extension Timing Function: This timing function shall carry over (i.e., extend) the call output up to seven seconds after the vehicle leaves the loop sensor. The timer shall be adjustable, from zero to seven seconds, in not more than 0.5-second increments.

When any of the above special functions are specified, then that special function shall be furnished on all channels of the same amplifier module.

(e) Amplifier Sensitivity:

Each of the amplifier channels shall have a minimum of three sensitivity settings per detection mode. The settings shall be selectable from the front panel. The highest sensitivity sheeting shall consistently respond to a loop inductance change of 0.02 percent. The lowest sensitivity setting shall respond to nominal loop inductance changes of from 0.15 to 0.4 percent. All modules must have sensitivities which differ by not more than ± 0.05 percent change in inductance from the nominal value chosen. A channel shall not respond to loop inductance changes less than 0.1 percent in the lowest sensitivity setting.

(f) Amplifier Response Time:

The amplifier channel response time in the lowest sensitivity setting shall be less than 20 milliseconds. For any negative inductive change which exceeds the sensitivity threshold, the channel shall output a ground true logic level within 20 milliseconds. When such inductance change is removed, the output shall become an open circuit within 20 milliseconds.

For test purposes, a negative change of inductance shall be maintained for a minimum of 100 milliseconds and a maximum of 600 milliseconds after it is applied. When the response time differences are averaged over 10 trials, the value of that average difference shall not exceed 10 milliseconds.

The response time of the detector channel for the highest sensitivity setting shall be less than 250 milliseconds for a 1.0 percent inductance change.

(g) Operating Frequency:

Each channel shall have a minimum of three operating frequencies. The frequency switch may be either on the front panel or on the circuit board. Frequency selection shall be possible without the use of tools.

(h) Detection Holding Time:

The detector channel, in the least sensitive position, shall maintain the presence detection of a vehicle for a minimum of four minutes while the vehicle is over the loop sensor and is causing an inductance change of 1.0 percent or greater.

The channel, in the highest sensitivity position, shall maintain the presence detection of a vehicle for a minimum of three minutes while the vehicle is over the loop sensor and is causing an inductance change of 0.02 percent or greater.

(i) Temperature Changes:

The operation of the amplifier shall not be affected by environmental temperature changes at the rate of 1.5 degrees F per three minutes.

(j) Interference:

Each channel shall not cause crosstalk with any other channel either within the same amplifier or within any other amplifier that is mounted in the same cabinet assembly. An amplifier channel shall not detect vehicles, moving or stopped, at distances of 3 feet or more from the loop perimeter to which it is connected.

(k) Lightning Protection:

Each amplifier shall have lightning protection as an integral part of its own circuitry. The protection shall enable the detector to withstand the discharge of a 10-microfarad capacitor, charged to 1,000 volts. The discharge shall be applied directly across the detector loop input pins with no loop load present.

The protection shall enable the detector to withstand the discharge of a 10-microfarad capacitor, charged to 2,000 volts. The discharge shall be applied directly across either the detector loop input pins or across either side of the loop input pins to earth ground. For this test, the detector chassis shall be grounded and the detector loop input pins shall have a 5.0-ohm dummy resistive load connected across them.

(l) Fail-safe Operation:

Each channel shall have a fail-safe design such that if the loop sensor circuit is open, the channel shall output a continuous vehicle call.

(m) Isolation Transformers:

Each loop sensor shall be coupled to the channel input by isolated transformers. The isolated input shall provide continued operation of the channel if the loop sensor in the street becomes grounded or has resistive leakage to ground.

(4) Magnetometer Detector Amplifier:

(a) General:

The magnetometer detector shall detect all licensed motor vehicles when using the probe configuration shown on the plans.

(b) Amplifier Requirements:

The amplifier shall be operational with up to 12 probes per channel, up to 2,000 feet of lead-in cable, and vehicular speeds up to 90 miles per hour. Each amplifier shall have two independent channels per card. The card shall be connectable in any detector rack position.

Solid state circuitry shall accurately measure changes in the earth's vertical magnetic field intensity caused by motor vehicles. The front panel shall have a calibration control for each channel to calibrate the amplifier for the local magnetic field strength.

Each amplifier channel shall have a front panel mounted indicator to provide a visual indication of each vehicle detection. The indicator shall be visible in bright sunlight.

Each channel call output shall be an optically isolated solid state NPN transistor with a normally open collector which shall be rated for a 5-milliampere load and 0.7-volt drop maximum.

The collector shall be rated for 30-volts DC when in the off mode. Each magnetometer amplifier shall conform to the magnetometer table and the following requirements:

(c) Detection Modes:

Each channel shall permit the selection of either a presence mode or a pulse mode. Each channel shall be independent of the other channel of the amplifier. In the presence mode, the channel shall indicate the presence of a vehicle until the vehicle leaves the detection area. The indication shall then cease in 100 milliseconds. In the pulse mode, the channel shall output a single 30- to 50-millisecond pulse for each vehicle entering the detection area.

(d) Timing Functions:

Each channel shall have the following independently selectable functions. The functions shall be selectable from the front panel:

(i) Inhibit Pulse Timing:

This timing function shall inhibit subsequent call outputs up to five seconds after each vehicle leaves the sensor area.

(ii) Extended Presence Timing:

This timing function shall carryover or extend the call output up to five seconds after each vehicle leaves the sensor area.

(e) Environmental:

The operation of the amplifier shall not be affected by nominal changes in the environment.

(f) Number of Probes:

Each amplifier channel shall operate with one to twelve sensor probes.

Standard Input and Output Functions for Vehicle Detection Assembly			
Magnetometer Module 2-Channel			
Pin No.	**Function**	**Pin No.**	**Function**
A	Logic Ground	1	No Connection
B	+24-volt DC IN	2	No Connection
C		3	No Connection
D	Probe Set 1 (White)	4	
E	Probe Set 1 (Black)	5	
F	Output 1 (+)	6	
H	Output 1 (-)	7	
J	Probe Set 1 (Red)	8	
K	Probe Set 1 (Green)	9	
L	Chassis Ground	10	No Connection
M		11	
N		12	
P	Probe Set 2 (White)	13	
T	Output 2 (-)	16	
U	Probe Set 2 (Red)	17	
V	Probe Set 2 (Green)	18	
W		19	
X		20	
Y		21	
Z		22	

A polarization key shall be located between pins R/4 and S/15.

(5) External Detector Inputs:

Each pedestrian push button, bicycle push button, or remote vehicle detector call input to the controller shall be isolated from the controller's logic ground by an auxiliary isolation relay. The isolation relay will be provided and installed by the Department. The size of the relay will be 1.6 inches wide by 2 inches long. The terminal strip shall be provided and wired by the contractor.

The terminal strip shall be the Type 141 with terminals in multiples of four. The size shall be 1-1/8 inches wide by 1/2 inch deep. The terminal spacing shall be 7/16 inch. The screw size shall be 6-32.

(a) Terminal Strip - A-Side:

The isolation relay shall be mounted on the A-side of the terminal strip. The A-side shall be the left hand side when the terminal strip is mounted vertically, the top side when the terminal strip is mounted vertically, or the top side when the terminal strip is mounted horizontally. Terminal No. 1 shall be the top terminal when mounted vertically or the first terminal from the right when mounted horizontally. A field terminal shall be provided to connect the detector call field inputs to the A-terminal strip.

(b) Terminal Strip - B-Side:

The B-side of the terminal shall be wired as follows for each relay required:

Terminal	Function
1	+12 or 24-volt (DC or AC)
2	Logic ground
3	(N.O.) Det. Call (for specified phase)
4	Det. call field input (for specified phase)

A power supply external to the controller shall be provided for the isolation relays. The controller power supply shall not be used for this purpose.

734-2.05 External Logic Circuit Boards:

(A) General:

External logic that is required to supplement the controller or auxiliary control units shall be on solid state, plug-in cards. The logic cards shall be designed as specified herein.

The logic cards shall be the 22-pin, edge-connector or octal-base type. The pins shall be either single- or double-sided as required.

Each card shall be keyed to prevent the improper connection of the card. The printed circuit board shall meet the requirements of NEMA TS1-14.2.3.

Power supplied from the controller's power supply shall not exceed 350 milliamperes. If more than 350 milliamperes is required, then a separate external power supply must be utilized. Such an external power supply may be either shelf-mounted or rack-mounted.

The logic circuitry shall be properly interfaced and buffered from the controller and other controller assembly equipment.

All external logic timing functions shall be digital and shall be in the required timing range. Timing entries shall be front-panel programmed without the use of tools or software and shall be accessible without the removal of the enclosure's cover. The timing shall be set by thumbwheel switches, programming pins, or digital binary (DIP) switches. The timing accuracy shall conform to NEMA TS1-2.1.11 for digital timing.

(B) Digital Time Switch:

When specified, each controller cabinet shall include a solid state digital time switch of the type specified, wired for the function detailed in the Special Provisions or plans.

The solid state digital time switch shall utilize solid state circuitry and digital timing techniques. Integrated or discrete semi-conductor devices shall be used exclusively. No electro-mechanical parts shall be employed except for the controlled circuit output relay.

The design life of all components under 24-hour-a-day operation in their electrical applications shall be not less than 10 years.

All components shall be clearly identifiable by markings on circuits boards or parts numbers on pictorial diagrams.

(1) Operational Requirements:

Each time switch shall control the required number of circuit outputs in a 24-hour period, for seven days with an omit control for any one or more of the seven days.

The time switch shall be powered by a 120-volt 60-hertz input in the temperature range between 30 and 165 degrees F. The 60-hertz line frequency shall be the time base for the clock.

(2) Time Clock Back-up:

The time switch shall have a battery back-up circuit which shall power the timer for not less than 12 continuous hours during the loss of electrical A.C. power. Battery back-up shall generate its own time base, and clock accuracy shall be within 0.02 percent. During battery back-up operation, all luminous displays and relays shall be disabled. During normal operation, the battery shall be trickle charged. The rechargeable battery system shall be an integral part of the time switch housing. The battery unit shall include an on-off control switch to permit it to be disconnected from the time switches.

(3) Programming:

Programmed time entries shall be front-panel programmed without the use of tools or software. The programming of the selectable functions

and time operations shall be set by thumbwheel switches, programming pins, DIP switch, or front-panel keyboard entry.

All programming pins shall be the printed circuit receptacle, non-corrosive, turning-fork type. The pin contactor shall fit any standard 0.055-inch to 0.73-inch board. The pins shall be rated 600 volts RMS at 5 amperes.

The time operations shall be programmable to a one-minute increment.

(4) Displays:

The time switch shall have a digital time-of-day display; 24-hour or with A.M./P.M. indicator; in hours and minutes past midnight. There shall be a day-of-the-week-in-effect indicator.

A separate indicator shall indicate when an output circuit is active (on).

(5) Output Control Circuit:

Each output control circuit shall be a single-pole, double-throw independent relay output. The relay shall be rated not less than 5 amperes at 120 volts AC. The relay shall be energized when the clock program is on, and de-energized when the clock program is off.

(6) Power Supply:

The time switch shall have the 120-volt AC input fused to protect its internal circuitry. Line transients normally experienced in traffic signal controller environments shall not affect the clock accuracy herein specified. Line transient protection devices shall be provided to prevent these inaccuracies.

(7) Housing and Connector:

The entire time switch shall be completely enclosed in a dust resistant housing. The housing door shall enclose all the program switches, display and indicators.

The housing shall contain solderless lug-type terminals or a detached connector.

(8) Digital Time Switch Types:

The solid state digital time switches shall be designated in the Special Provisions or plans with the following five-position alphanumeric code. The code shall have the following meaning:

The type DTS clock shall mean the solid state digital time switch.

DTS-1-1 is a single program, single circuit.

DTS-1-3 is a single program, three-circuit.

DTS-3-3/4 is a three program, three or four-circuit as required.

The single program shall have seven on-off operations per unit and three on-off operations per circuit in a 24-hour period.

Each program shall be selectable for day omit (days 1 through 7).

The solid state time switches shall have an 11-pin octal connector. The cabinet shall have a female interface connector as shown in the following table:

Cabinet Solid State Time Switch Interface Connector	
Pin No.	**Function**
1	Common No. 1
2	Output No. 1 N.O.
3	Output No. 1 N.C.
4	Common No. 2
5	Output No. 2 N.O.
6	Output No. 2 N.C.
7	AC Common
8	Common No. 3
9	120-volt AC Input
10	Output No. 3 N.C.
11	Output No. 3 N.O.

734-3 Construction Requirements:

734-3.01 General Requirements:

All traffic controller assembly equipment shall be furnished and installed as shown on the plans, and in accordance with the Special Provisions and these specifications. Cabinet wiring, connecting cables, support bases, and shelves shall be provided to allow for future installation and use.

734-3.02 Test Requirements:

(A) General:

All specified traffic controller assembly items shall meet the applicable environmental and testing standards of NEMA Publication TS-1. All traffic signal controller units shall be tested by the Department's testing procedures.

734-3.03 Wiring and Grounding Requirements:

(A) Cabinet Wiring:

All cabinet wiring shall be neatly arranged and made tight by the use of wiring harnesses, cable sheaths, cable wraps, or raceways. All wires in a harness shall be laced or bound together. Harnesses shall be routed to minimize crosstalk and electrical interference.

Cabling shall be routed to prevent conductors from being in contact with metal edges. Cabling shall be arranged so that any removable assembly may be removed without disturbing conductors not associated with that assembly.

All pin assignments shall be wired to the controller cabinet terminal for future use.

The following time-base coordination wiring functions shall be provided when MPS coordination is specified to be furnished in the control cabinet:

(1) Fully actuated controller units shall be wired to operate in non-actuated mode during coordination period;

(2) The inside cabinet switch panel shall include a switch for coordination, and free run modes of operations. The remote free input shall be wired to a cabinet terminal tie point to permit control input from a remote input; and

(3) An auxiliary time of day (24-hour) from the MPS "D" connector output shall be wired in the cabinet to program the Max 2 Function.

(B) Conflict Monitor Wiring:

The conflict monitor unit cable shall be wired to perform the following functions:

(1) To monitor conflicts of green, yellow and walk signal for each applicable phase;

(2) To monitor absence of red voltage. Any phase specified for future use shall have a removable jumper so as to permit future implementation of that phase without rewiring the controller cabinet;

(3) To monitor voltage +24-volt DC source of the controller unit and any auxiliary controller unit;

(4) To start-delay the controller unit per NEMA Standards;

(5) The conflict monitor cable shall have the cabinet interlock A and B wired to control cabinet tie points for future use; and

(6) The monitor input for each signal circuit shall be terminated at the furthest field terminal point, so as to monitor both the automatic and flash modes of the controller cabinet.

(C) Cabinet Grounding:

All controller cabinets and auxiliary cabinets shall have the AC common, the logic ground, and the chassis ground isolated from each other as detailed in the current NEMA Standards.

(D) Field and Tiepoint Terminal/Wiring:

(1) Controller Cabinet:

All field terminals shall be installed on a terminal support which shall be located at the rear of the lower portion of the controller cabinet and not less than 5 inches from the base of the cabinet.

All connectors for field terminals shall be connected to barrier-type terminal blocks. Each terminal block position shall have two No. 10-32 screw connectors (not less than 3/8 inch in length), and a removable shorting bar. Each terminal shall accommodate at least three No. 12 AWG conductors. The terminal block shall have a labeling strip for each position.

All controller assembly wiring tie points on the front side of the terminal blocks shall be the spade type. Tie points of the back side of terminal blocks shall be soldered to a lug. All crimp style connectors shall be applied with the proper tool. The tool's handles shall not open until the crimp is completed. Each terminal position shall be permanently labeled at the terminal position. Tie points shall be required for all controller unit and auxiliary control equipment circuits.

(2) Pre-emption Cabinet Wiring:

The pre-emption cabinet shall include a load switch circuit to operate the pre-emption "No Right Turn" illuminated message signal (120-volt AC output). The field terminals shall include the following terminal positions:

(a) To railroad (120-volt AC);

(b) From railroad (not wired); and

(c) "No Right Turn" signal.

734-3.04 Cabinet Wiring Diagrams:

Each controller cabinet assembly shall have a complete set of wiring diagrams which shall show the intersection plan, signal phasing layout, and all control device connections.

Two sets of the final wiring diagrams and a second original shall be required with delivery with each control cabinet assembly. The second original shall be a legible reproducible linen cloth, mylar film, or polyester film.

Each controller cabinet shall be furnished with a sheet metal wiring diagram print holder. The minimum size of the print holder shall be not less than 9 inches wide by 8 inches high by 1-1/4 inches deep, mounted inside.

734-3.05 Cabinet Foundations:

Before the concrete for cabinet foundations has set, depressions shall be made around the anchor bolts for adjustment of the cabinet leveling nuts. Cabinet foundations shall be 4 inches above ground level.

734-4 Method of Measurement:

Traffic signal control cabinets and meter pedestal cabinets will be measured as a unit for each controller assembly or control cabinet furnished and installed.

734-5 Basis of Payment:

The accepted quantities of traffic signal control cabinets and meter pedestal cabinets, measured as provided above, will be paid for at the contract unit price each for the type controller assembly or control cabinet designated in the bidding schedule, complete in place, which price shall be full compensation for the work described and specified herein and on the plans, including service terminal boxes, cabinet mounted service enclosures, meter sockets, breaker panels, foundations, conduit, elbows, anchor bolts, clearance pad, auxiliary signal controls, external logic modules and all other components necessary to provide a complete functional assembly for controlling the operation and timing of traffic control signals.

SECTION 735 DETECTORS:

735-1 Description:

The work under this section shall consist of furnishing and installing traffic signal loops, preformed loop detectors, complete or partial traffic data loop and weigh-in-motion (WIM) systems, and pedestrian detectors

at the locations shown on the project plans and in accordance with the details shown on the plans and the requirements of the specifications.

735-2 Materials:

735-2.01 Vehicle Detectors:

(A) General:

Detectors shall conform to the minimum acceptable design and operating requirements of these specifications for detecting the presence, passage, speed, weight, and classification of vehicles.

Except as specified in Subsection 735-2.01(F) of the specifications, all materials shall be furnished by the contractor. The contractor shall submit a complete list of all required project material for approval, as specified in Subsection 730-4 of the specifications.

(B) Loop Detectors:

The detector loop dimensions shall be as specified on the Standard Drawings.

Loop detector wire shall be 14 AWG HDPE polyethylene insulated conductors conforming to IMSA 51-7, as shown on the Standard Drawings.

(C) Lead-in Cable:

For Type SA and SB speed/classification detectors specified in Subsection 735-3.02(D) of the specifications, lead-in cable from the pull box to the cabinet shall conform to IMSA specification 50-2, except as modified on the Standard Drawings.

(D) Conduit:

Conduit shall be rigid nonmetallic PVC conforming to the requirements of Subsection 732-2.02 of the specifications. Conduit shall be large enough to contain the number of wires required, but not less than the diameters shown on the Standard Drawings.

(E) Cabinets:

Traffic monitoring site cabinets for Type SA and SB speed/classification and WIM detectors shall be pole-mounted Type MPD control cabinets as shown on the Standard Drawings, and as specified in Subsection 734-2.03 of the specifications, except that no pre-wiring for AC or DC electric, police panel, or provisions for fan or light shall be required.

Warranties shall comply with Subsection 106.13 of the specifications.

(F) Department Furnished Materials:

When required, the Department will furnish detectors for speed/classification systems (piezoelectric sensors-Class 2) and weigh-in-motion systems (piezoelectric sensors–Class1, or quartz piezoelectric sensors) with pre-attached lead-in cables. For such installations, the Department will also furnish the piezo grout sealant for the sensor portion of speed/classification and weigh-in-motion detectors. The contractor shall furnish all other sealants.

The contractor shall notify the Traffic Monitoring Team of the Multimodal Planning Division (MPD) at (602) 712-8598 a minimum of 15 working days prior to scheduled installation of the Department-furnished piezoelectric sensors. The required sensors and grout will be provided at the Department's central Phoenix location, at 2501 W. Georgia, Phoenix, AZ 85017, or at the appropriate District Office, as specified by the Department at the time of contact.

735-2.02 Pedestrian Push-Button Detectors:

The pedestrian detector shall be a push-button switch mounted inside an approved push-button housing, as shown on the Standard Drawings.

Pedestrian push-button signs shall be made with porcelain enameled 20 gage sheet steel, 9 inches by 12 inches in size. Corners of the sign shall be finished round for safety and neat appearance. Each hole shall be provided with a brass grommet. Instructions on the signs shall be black enameled letters or symbols on a white enamel background. The legend shall be as shown on the plans or as specified in the Special Provisions.

735-2.03 BLANK:

735-2.04 Saw Cut Sealant:

Saw cut sealants shall be a flexible encapsulant intended for sealing and protecting vehicle detector loop wires installed in saw cuts.

(A) Two-Part Epoxy Filler Sealant :

Two-part epoxy joint filler sealant shall be a 100-percent solids, flexible, two-component, solvent free, epoxy resin/hardener system for use as a saw cut sealant in asphaltic concrete pavements and Portland cement concrete pavements.

Materials shall comply with the requirements of Subsection 1015-1 of the specifications.

The epoxy system shall be specifically designed for the intended application according to the product literature provided by the manufacturer.

The epoxy system shall be of sufficient strength and hardness to withstand stress and abrasion from vehicular traffic, while remaining flexible enough to provide stress relief under thermal movement and protect the loop wire from moisture penetration. It shall also be moisture insensitive to allow effective application to damp pavements. No standing water is permitted on the surfaces to which the epoxy system is to be applied.

The epoxy system shall be designed to enable vehicular traffic to pass over properly filled saw cuts immediately after installation without tracking or stringing of the material.

Properly installed and cured epoxy systems shall exhibit resistance to the effects of weather, motor oils, gasoline, anti-freeze solution, brake fluid, deicing chemicals, and salt in such a manner that the performance of the vehicle detector loop wire is not adversely affected.

The epoxy system shall be designed for roadway installation when the surface temperature is a minimum of 40 degrees F and rising. The cured epoxy system shall be temperature stable and exhibit no degradation in performance throughout the ambient pavement temperature ranges experienced within the State of Arizona.

The components of the epoxy system shall have a minimum shelf life of 12 months in original unopened, undamaged containers, when stored in a cool dry environment, as recommended by the manufacturer.

The epoxy system shall meet the following requirements:

Property	Test Method	Requirements
Mixing Ratio; Part A to Part B	-	1 to 1 by volume
Viscosity, centipoises	ASTM D2393	4000 to 8000
Pot Life, minutes	ASTM C881	12 to 20
Cure Time, minutes	ASTM C679	60 maximum, Tack Free
Hardness (Shore D)	ASTM D2240	35 to 65
Tensile Elongation, %	ASTM D638	50 minimum
Water Absorption, % (24 hrs)	ASTM D570	1 maximum
3% Salt Water Absorption, % (24 hrs)	-	0.03 to 0.20
Oil Absorption, % (24 hrs)	ASTM D471	0.01 to 0.02
Gasoline Absorption, % (24 hrs)	-	0.05 to 0.90

(B) One-Part Elastomeric Sealant:

One-part elastomeric sealant may be used to seal saw cuts in Portland cement concrete pavement and lean concrete base.

The sealant shall provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in concrete pavements, while protecting the loop wire from moisture penetration.

The encapsulant shall be a one-part elastomeric compound requiring no mixing, measuring or application of heat prior to or during its installation.

The encapsulant shall, within its stated shelf life in original undamaged packaging, cure only in the presence of moisture. The rate of cure will, therefore, depend upon temperature and relative humidity at the time of installation. Cool dry weather will slow curing whereas warm, humid weather will accelerate curing.

The encapsulant shall be designed to enable vehicular traffic to pass over the properly filled saw cut immediately after installation without tracking or stringing of the material. The encapsulant shall form a surface skin allowing exposure to vehicular traffic within 30 minutes at 75 degrees F and completely cure to a tough, rubber-like consistency in two to seven days after installation.

Properly installed and cured encapsulant shall exhibit resistance to effects of weather, vehicular abrasion, motor oils, gasoline, anti-freeze solution, brake fluid, deicing chemicals and salt normally encountered, in such a manner that the performance of the vehicle detector loop wire is not adversely affected.

The cured encapsulant shall be temperature stable and exhibit no degradation in performance throughout the ambient pavement temperature ranges experienced within the State of Arizona.

The encapsulant shall exhibit minimal shrinkage during or after its installation, and in no manner affect the performance characteristics of the material.

The encapsulant shall be designed to permit clean-up of material and application equipment , prior to curing of the encapsulant, with a suitable non-flammable solvent. Should any encapsulant material be allowed to cure in the application nozzle, it shall be able to be pulled out as a solid plug.

The encapsulant shall have a minimum 12-month shelf life in undamaged original containers when stored in a cool, dry environment.

The encapsulant shall be designed for roadway installation when the surface temperature is between 40 and 140 degrees F.

The encapsulant shall have the following physical properties in its uncured and cured states.

Uncured (Wet) Encapsulant		
Property	**Requirement**	**Test Procedures**
Weight	10.1 ± 0.3 pounds/gallon	A. Weight/Gallon
Total Solids by Weight	75 – 85%	B. Determination of Non-Volatile Content
Viscosity	10,000 - 85,000 centipoise	C. Dynamic Viscosity
Drying Time	Touch: 24 hrs. maximum Complete: 30 hrs. max.	D. Tack-Free Time

Cured Encapsulant		
Property	**Requirement**	**Test Procedure**
Hardness (Indentation)	65 - 85	E. Rex hardness
Tensile Strength	500 psi minimum	F. Tensile & Elongation
Elongation	300% minimum	

(C) Hot Applied Rubberized Sealant:

Hot applied rubberized sealant may be used to seal saw cuts in asphaltic concrete and in lean concrete base. It shall be suitable for use as a sealant for traffic loop saw cuts and be non-tracking under traffic. At application temperatures, the traffic loop sealant shall be a thin, free flowing fluid which penetrates saw cuts and self-levels permitting uniform application. The sealant shall be melted and applied to pavements using a pressure feed melter unit. Pour pot application is not acceptable. The sealant shall be a relatively stiff sealant but shall remain flexible at low pavement surface temperatures. The test results shall conform to the following specifications for the loop detector sealant.

Test	Specification
Penetration: 125 °F, 50g, 5s	50 maximum
Penetration: 77 °F, 100g, 5s	10 - 25
Softening Point:	210 °F minimum
Ductility: 77 °F	15 cm minimum
Mandrel Bend: 0 °F, 90° Arc, 10s, 3/4 inch diameter	Pass 2 of 3
Recommended Pour Temp:	380 °F
Safe Heating Temp:	420 °F
Brookfield Viscosity: 400 °F	7,500 centipoise max.
Unit Weight:	8.5 pounds per gallon
Coverage; 1/2 by 1/2 inch crack	11.0 pounds per 100 feet

735-3 Construction Requirements:

735-3.01 Detector Installation:

(A) General:

Detectors shall be installed as shown on the project plans, as shown in the Standard Drawings, and as directed by the Engineer. The installation of the detectors shall be such that the operation shall not be affected by temperature changes, water, ice, rain, snow, chemicals, or electromagnetic noise.

Vehicle detectors shall be installed prior to any chip seal or friction course for asphaltic concrete pavements, and prior to any friction course for Portland cement concrete pavements.

(B) Saw Cut Sealants:

Saw cuts shall be sealed as specified in the Standard Drawings, with the following exceptions:

(1) Two-part epoxy filler sealant shall be used instead of pre-mixed emulsified crack filler sealant; and

(2) Department-furnished piezo grout shall be used to seal the piezo sensor portion of speed/classification and weigh-in-motion detectors.

Before the sealant sets up, the surplus sealant shall be removed from the road surface without the use of solvents. Sand blotter shall be applied as directed by the Engineer.

(C) Splices:

Except for piezoelectric or quartz piezoelectric sensors, detector sensor conductors shall run continuous and unspliced to the adjacent pull box. Lead-in cables from the controller cabinet shall be spliced to the detector sensor conductors in the pull box. Splicing of the lead-in cables between the controller cabinet and pull box will not be allowed.

Piezoelectric sensor and quartz piezoelectric sensor lead-in cables used in speed/classification detectors and weigh-in-motion detectors shall run continuous and unspliced through the pull box to the controller cabinet. Splicing of the lead-in cables will not be allowed.

Wire splices in the pull box shall be soldered using resin-core solder with 60 percent tin and 40 percent lead. The splices shall be sealed as specified in the Standard Drawings. A weather proof bond shall form with a dielectric strength of 500 volts per mil, and water absorption shall

be less than 6.5 percent. The detector lead-in cable shield shall only be grounded on one end in the control cabinet.

(D) Detector Loop Field Tests:

Detector loop field tests shall be in accordance with the Standard Drawings.

Any loop that fails to meet the specified requirements or cannot be tuned to the Engineer's satisfaction shall be replaced at no additional cost to the Department.

For the traffic data detectors specified in Subsection 735-3.02 of the specifications, the contractor shall submit complete test results to the Engineer electronically within two weeks of completion of the second test. In addition to the electronic submission, the Engineer may request up to three hard copies. The test results shall identify the project number and detector location.

For pull boxes used with data detector systems, the contractor shall provide GPS latitude and longitude coordinates, ± 5 feet, for each installed pull box. Such GPS information shall be transmitted along with the test data required above for all pull boxes installed with each tested data detector loop system.

735-3.02 Traffic Data Detectors:

(A) General:

Counter (Type C), speed/classification (Types SA and SB), and weigh-in-motion (WIM) detector systems shall be installed in accordance with the Standard Drawings and as specified herein.

The contractor shall use a 3/4-inch wide saw blade to cut the channel for piezoelectric sensors in pavement. Multiple passes using a thinner blade will not be acceptable.

When new conduit is required under any existing pavement, the contractor shall install conduit beneath the roadway using horizontal directional drilling methods approved by the Engineer.

Pull boxes shall be as shown on the Standard Drawings.

As specified above in Subsection 735-3.01(D) of the specifications, the contractor shall provide GPS latitude and longitude coordinates, ± 5 feet, for all pull boxes installed with each traffic data detector loop system.

(B) Installation of Piezoelectric Sensors:

The contractor shall install the Department-furnished piezoelectric or quartz piezoelectric sensors, and piezo grout, as specified herein and shown on the plans. A traffic signal technician from the Department must be present during all elements of the piezoelectric sensor installation (to the point where the pre-attached lead-in cable begins), including layout, groove saw-cutting, sensor placement, and application of piezo grout. The contractor shall notify the Engineer at least 15 working days prior to its scheduled installation of any piezoelectric sensors. Any piezoelectric sensor installation work performed without full time inspection by the Department's traffic signal technician may not be eligible for payment.

Lead-in runs of cable from all piezoelectric sensors and quartz piezoelectric sensors to the controller cabinet shall be continuous; splices will not be acceptable.

(C) Traffic Counter Detectors:

A complete new traffic counter system (Type C) shall include all loops and pull boxes for the specific location for both directions of traffic, as shown on the Standard Drawings. A divided roadway shall require a pull box on each shoulder. Loop detector traffic counter systems shall include all necessary conduits from edge of pavement to the roadside pull box(es).

The contractor shall provide a trench and install conduit from the edge of pavement to the pull box. Wiring, conduit, and pull box installation shall be in accordance with Subsections 732-3.01 and 732-3.02 of the specifications.

When a full replacement of an existing traffic counter system is indicated on the plans and bidding schedule, the contractor shall remove the existing facilities, and furnish and install new loops, pull boxes, and conduit.

The total number of loops for each complete traffic counter system specified above (new or full replacement) shall be the number of loops required for all traffic lanes in both travel directions at the specified location.

(D) Speed/Classification Detectors:

A complete new speed/classification system (Type SA or Type SB) shall include all loops, pull boxes, control cabinet, A-pole, pole foundation, the necessary conduits under the roadway and from pull boxes to control cabinets, and Department-furnished piezoelectric sensors with attached lead-in cables, all as shown on the Standard Drawings. When shown on the plans, an additional control cabinet, pull box, A-pole, and pole foundation shall be required.

The contractor shall provide trenches and install conduits from the edge of pavement to the pull box and from the pull box to the control cabinet. Wiring, conduit, and pull box installation shall be in accordance with Subsections 732-3.01 and 732-3.02 of the specifications.

Installation of Department-furnished piezoelectric sensors shall be in accordance with Subsection 735-3.02(B) of the specifications.

The cabinet(s) shall be grounded in accordance with the requirements of Subsections 732-3.03 and 734-3.03 of the specifications. The contractor shall keep the ground wire from the cabinet ground bus bar to the ground rod assembly or array as short as possible.

When a full replacement of an existing speed/classification system is indicated on the plans and bidding schedule, the contractor shall remove the existing facilities, and furnish and install new loops and pull boxes, a new control cabinet, A-pole and foundation, all necessary conduits under the roadway and from pull boxes to control cabinets, and Department-furnished piezoelectric sensors with attached lead-in cables. When shown on the plans, an additional control cabinet, pull-box, A-pole, and pole foundation shall be required.

When a partial replacement of an existing speed/classification system is indicated on the plans and bidding schedule, the contractor shall furnish and install new loops and pull boxes, and new Department-furnished piezoelectric sensors with attached lead-in cables. The contractor shall use the existing cabinet(s), A-pole(s) and foundation(s), and all conduit connections under the roadway and from pull boxes to the cabinet.

The total number of loops for each complete speed/classification system specified above (new, full replacement, or partial replacement) shall be the number of loops required for all traffic lanes in both travel directions at a specified location.

(E) Weigh-in-Motion (WIM) Detectors:

A complete new weigh-in-motion (WIM) system shall include all loops, pull boxes, control cabinet, A-pole, pole foundation, the necessary conduits under the roadway and from pull boxes to control cabinets, and Department-furnished sensors (piezoelectric or quartz piezoelectric as shown on the plans) with attached lead-in cables, all as shown on the Standard Drawings. When shown on the plans, an additional control cabinet, pull box, A-pole, and pole foundation shall be required.

The contractor shall provide trenches and install conduits from the edge of pavement to the pull box and from the pull box to the control cabinet. Wiring, conduit, and pull box installation shall be in accordance with Subsections 732-3.01 and 732-3.02 of the specifications.

Installation of Department-furnished piezoelectric sensors shall be in accordance with Subsection 735-3.02(B) of the specifications.

The cabinet(s) shall be grounded in accordance with the requirements of Subsections 732-3.03 and 734-3.03 of the specifications. The contractor shall keep the ground wire from the cabinet ground bus bar to the ground rod assembly or array as short as possible.

When a full replacement of an existing new WIM system is indicated on the plans and bidding schedule, the contractor shall remove the existing facilities, and furnish and install new loops and pull boxes, a new control cabinet, A-pole and foundation, all necessary conduits under the roadway and from pull boxes to control cabinets, and Department-furnished piezoelectric sensors with attached lead-in cables. When shown on the plans, an additional control cabinet, pull-box, A-pole, and pole foundation shall be required.

When a partial replacement of an existing WIM system is indicated on the plans and bidding schedule, the contractor shall furnish and install new loops and pull boxes, and new Department-furnished piezoelectric sensors with attached lead-in cables. The contractor shall use the existing cabinet(s), A-pole(s) and foundation(s), and all conduit connections under the roadway and from pull boxes to the cabinet.

The total number of sensors for each complete new WIM system specified above (new, full replacement, or partial replacement) shall be the number of sensors required for all traffic lanes in both travel directions at a specified location.

735-3.03 Traffic Signal Detectors:

Traffic signal detectors shall be as shown on the Standard Drawings, and shall include the specified loop, wiring, and conduit required to terminate the wiring in the pull box.

The contractor shall provide a trench and install conduit from the edge of pavement to the pull box. Wiring, conduit, and pull box installation shall be in accordance with Subsections 732-3.01 and 732-3.02 of the specifications.

735-3.04 Preformed Traffic Detectors:

Preformed loop detectors for ramp metering and counting shall comply with the Standard Drawings, and shall include the specified loop, wiring, and conduit required to terminate the wiring in the pull box.

Preformed loop detectors in Portland cement concrete pavement shall comply with the Standard Drawings, and shall include the specified loop, wiring, and conduit required to terminate the wiring in the pull box.

The contractor shall provide a trench and install conduit from the edge of pavement to the pull box. Wiring, conduit, and pull box installation shall be in accordance with Subsections 732-3.01 and 732-3.02 of the specifications.

Preformed loop detectors in bridge deck shall comply with the Standard Drawings, and shall include the specified loop, wiring, and conduit required to terminate the wiring in the junction box.

735-4 Method of Measurement:

Traffic signal detectors, preformed loop detectors, and pedestrian detectors will be measured as a unit for each type of detector furnished and installed.

Traffic data detectors, consisting of counter loop detectors (Type C), speed/classification detectors (Type SA or Type SB), and weigh-in-motion (WIM) detectors will be measured as a complete system for each type of traffic data detector furnished and installed, including all loops required for both directions of traffic. Speed/classification detectors, regardless of type, and weigh-in-motion detectors will be measured as a new system, full system replacement, or partial replacement, as specified herein and indicated on the bidding schedule. Counter detectors will be measured as a new system or full system replacement, as specified herein and indicated on the bidding schedule.

Speed/classification and weigh-in-motion detectors that include two cabinets, A-poles, and pole foundations (two-cabinet systems) will also be measured as a complete new system, including all loops in both directions of traffic, regardless of the distance between both directions of traffic.

735-5 Basis of Payment:

Traffic signal detectors, preformed loop detectors, and pedestrian detectors, measured as provided above, will be paid for at the contract unit price each for the type detector designated in the bidding schedule, complete in place, which price shall be full compensation for the work described and specified herein and on the plans.

Traffic data detectors, measured as provided above, will be paid for at the contract unit price for each complete type of data detector system designated in the bidding schedule, complete-in-place, regardless of the number of loops, including all conduit, wiring, pull boxes and, when specified, cabinets, poles, and pole foundations, which price shall be full compensation for the work described and specified herein and on the plans.

No measurement or payment will be made for horizontal directional drilling, the cost being considered as included in contract items.

SECTION 736 HIGHWAY LIGHTING:

736-1 Description:

The work under this section shall consist of furnishing and installing or modifying highway lighting systems at the locations shown on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

The work as described above shall include furnishing and installing all materials and equipment designated on the project plans necessary for the installation of future systems.

736-2 Materials:

736-2.01 Highway Lighting Materials:

Highway lighting materials shall be Light Emitting Diode (LED), conforming to the requirements of this section and be of the type and size specified. The LED shall have a nominal Correlated Color Temperature (CCT) equal to 3,000 degrees K ± 300 degrees K, or as specified in the project plans.

LED luminaires shall be listed by a National Recognized Laboratory (NTRL) as defined by US Department of Labor. The testing laboratory must be listed by OSHA in its scope of recognition for the applicable tests being conducted as required by this specification. A list of recognized testing labs for products sold in the United States may be found on the US Department of Labor website at http://www.osha.gov.

(A) Requirements:

Each luminaire shall be furnished with an instruction sheet which clearly shows installation procedures and instructions for adjusting the luminaire. Each luminaire should meet the following requirements:

(1) Listed by NTRL as being in compliance with Underwriters Laboratories (UL) 1598 and suitable for use in wet locations;

(2) Shall have an International Electro-Technical Commission (IEC) 529 Ingress Protection (IP) 65 or greater for the optical assemblies of the luminaire;

(3) Comply with Electro Magnetic Interference (EMI) requirements as defined by FCC47 Sub Part 15; CISPR15, CISPR22 Class A (120 volt minimum), EN61000-3-2, -3-3, -4-4, -4-5;

(4) Shall be tested according to the most current version of Illuminating Engineering Society of North America (IENSA) LM-79;

(5) Shall have lumen maintenance measured in accordance with the most current version of IESNA LM-80;

(6) Shall have long term lumen maintenance documented according to most current version of IESNA TM-21; and

(7) Shall have LM-79, LM-80 and in-situ temperature testing conducted by US Department of Energy Lighting Facts Program LED Lighting Facts approved testing laboratories.

(B) Luminaire Housing:

The luminaire housing shall be made of cast aluminum grade A383, A380 or A360, and painted to increase corrosion resistance; the color of the paint shall be gray unless specified otherwise. The luminaire housing shall serve as a passive heatsink for the LED array; no fans shall be allowed. All cast aluminum parts shall be subjected to the following tests:

(1) 1000 hours salt spray fog exposure in accordance with ASTM B117; and

(2) Corrosion Resistance Performance test in accordance with ASTM D1654.

The luminaire housing shall be compliant with American National Standard (ANSI) IEEE C136.31, Table 2 Roadway Lighting Equipment - Luminaire Vibration for both normal applications and bridge and overpass applications. Luminaire housing shall be rated IP65 per ANSI C136.37.

The luminaire housing shall be designed to allow water shedding. A passive cooling method shall be employed to manage thermal output of LED light engine and power supply. The luminaire housing shall have a label that states operating voltage, wattage and current range. The label must be clearly visible on the inside of the housing.

The luminaire housing shall have a National Electrical Manufacturers Association (NEMA) standard decal with black lettering identifying wattage and light type compliant with ANSI C136.15-2015.

Each luminaire shall be furnished with an instruction sheet which clearly shows installation procedures and instructions for proper luminaire aiming adjustments and maintenance instructions.

(C) Electrical Requirements:

The luminaire shall fully operate in a temperature range -40 degrees C to 40 degrees C (-40 degrees F to 104 degrees F).

The LED engine which is composed of LED modules, optical system, electronic driver and heatsink shall have a minimum expected life of 100,000 hours at 25 degrees C and 70 percent of initial lumen output (L70) as calculated according to TM21-11.

The luminaire shall have an integral dimming electronic driver that will operate for the following voltage ranges, as specified in the project plans:

(1) 120 to 240 VAC (rms) ± 10 percent at 60 hertz or the voltage option of 480 VAC (rms) ± 10 percent at 60 hertz, as specified in the project plans;

(2) The electronic driver shall have the following:

(a) A power factor of .90 or greater at full load;

(b) A total harmonic distortion of 20 percent or less at full load. ANSI C82.77, Harmonic Emission Limits;

(c) Thermal overload protection;

(d) 10 kA overload/overcurrent protection;

(e) A shielded and replaceable 20 kV surge protective device, compliant with ANSI C62.41 Category C; and

(f) NRTL certified dimming driver that is terminated with quick disconnect wire harnesses. Wire nut termination is not acceptable.

(D) LED Performance Requirements:

The luminaire shall have a minimum luminaire efficacy of 115 lumens/watt at 3,000 degrees K CCT. The luminaire shall meet the chromaticity requirements as follows:

(1) The colors shall conform to the following color regions based on the 1931 CIE chromaticity diagram; and

(2) The luminaire shall have a minimum Color Rendering Index (CRI) of 70. Chromaticity as stated above must be confirmed by an Independent test lab or shown on the LM 79 test report.

(E) Optical Requirements:

The luminaire shall have a completely sealed optical system with an IEC IP rating of 65 or better.

The luminaire shall have a light distribution pattern at the road surface that has an evenly dispersed appearance.

The luminaire shall not have a perceptible light level flicker to the unaided eye over the voltage range as specified in the Electrical Requirements.

(F) Warranty:

The entire LED unit including auxiliary equipment shall have a factory warranty of five years against defects in workmanship or materials. The warranty shall cover repair or complete replacement.

(G) Light Level Calculations:

The light level calculations shall be performed in accordance with current adopted Roadway Lighting Design Guide by the Department or latest IES RP-8, and must be documented through lighting design software using the Light Loss Factor (LLF) equation below:

$$LLF = LLD \times LDD \times LATF$$

Where:

LLD (Lamp Lumen Depreciation Factor) = the specified percentage of LED lumen maintenance at 70,000 hours at 25 degrees C (77 degrees F) from the TM-21 Report
LDD (Luminaire Dirt Depreciation) = 0.90
LATF = LED Ambient Temperature Factor

The LLD and LATF factors shall correspond to 40 degrees C. The TM-21 Report must show the drive current used for the submitted luminaire.

Product submittal shall be accompanied by IESNA TM-21 compliant test reports from a CALiPER qualified or NVLAP accredited testing laboratory for the specific model being submitted.

736-2.02 Horizontally Mounted LED Luminaries:

Horizontally mounted LED luminaries shall meet the requirements of Subsection 736-2.01 of the specifications and as specified herein. The luminaries shall be LED type 15L, 25L, or 40L as specified. Products listed on the Approved Products List (APL) are available on the internet from the ADOT Research Center through its Product Evaluation Program. Luminaries not currently on the APL may be considered, but must be

submitted to and reviewed by the Engineer prior to approval for use on the project. The contractor shall allow sufficient time for review and approval.

Based on Type V optical distribution and CCT of 3,000 degrees K:

Type 15L is intended to define an LED fixture with lumen output equal or greater than 13000 lumens but less than type 25L.

Type 25L is intended to define an LED fixture with lumen output equal or greater than 21000 lumens but less than type 40L.

Type 40L is intended to define an LED fixture with lumen output equal or greater than 29000 lumens.

(A) Luminaire Housing:

The luminaire housing shall have a slip fitter type mounting on nominal 1½ inch (1⅔ inch outside diameter) to 2 inch (2⅜ inch outside diameter) by minimum 4 inch pipe (Tenon); provided with stainless or zinc plated clamps fixed by four 2 inch by ⅜ inch zinc plated hexagonal bolts with spring washers. The housing shall include integral bubble level indicator and enable luminaire tilt adjustment of ± 5 degrees in 2.5 degree increments.

The luminaire housing shall allow tool less entry with a hinged, removable door that opens downward to allow access to electronic components and terminal block. The door shall be secured to prevent accidental opening or dropping.

The maximum weights for each type when fully assembled shall be as follows:

(1) Type 15L shall not weigh more than 30 pounds;

(2) Type 25L shall not weigh more than 40 pounds; and

(3) Type 40L shall not weigh more than 45 pounds.

The luminaire housing shall have an Effective Projected Area (EPA) of no more than 1.5 square feet (when viewed from either side or either end).

The luminaire housing shall be equipped with a seven-pin photo-electric control receptacle (PECR) conforming to ANSI Standard C136.10, and shall be provided with a shorting cap.

(B) Electrical Requirements:

The terminal block shall be 3-station, tunnel lug terminal board that will accommodate American Wire Gauge (AWG) #6 thru #12.

(C) Optical Requirements:

The luminaire shall have an IESNA Backlight, Up light and Glare (BUG) rating as follows:

(1) Backlight rating shall not exceed 3;

(2) Up light rating shall not exceed 0; and

(3) Glare rating shall not exceed:

(a) 3 for Type 15L and 25L; and

(b) 4 for Type 40L.

736-2.03 High Mast LED Luminaries:

High mast LED luminaries shall meet the requirements of Subsection 2.01 of the specifications and as specified herein. The luminaries shall be LED, specifically engineered and designed by the manufacturer for high mast lighting applications.

Luminaries must be submitted to and reviewed by the Engineer prior to approval for use on the project. The contractor shall allow sufficient time for review and approval.

(A) Luminaire Housing:

The luminaire housing shall have a slip fitter type mounting on nominal 1½ inch (1⅝ inch outside diameter) to 2 inch (2⅜ inch outside diameter) by minimum 4 inch pipe (Tenon); provided with stainless or zinc plated clamps fixed by four 2 inch by ⅜ inch zinc plated hexagonal bolts with spring washers. The housing shall include integral bubble level indicator and enable luminaire tilt adjustment of ± 5 degrees in 2.5 degrees increments.

The luminaire housing shall have a hinged, removable door.

The maximum weight for the high mast fixture when fully assembled shall not exceed 60 pounds.

The luminaire housing shall have an EPA of no more than 2.1 square feet (when viewed from either side or either end).

The luminaire housing shall be equipped with a seven-pin PECR conforming to ANSI Standard C136.10, and shall be provided with a shorting cap.

(B) Electrical Requirements:

The terminal block shall be 3-station, tunnel lug terminal board that will accommodate AWG #6 thru #12.

(C) Optical Requirements:

The luminaire shall have an IESNA Up light rating of zero.

The luminaire shall have a rotatable optics assembly to enable proper light distribution alignment.

Optional 90 degree, 120 degree, and 180 degree shields shall be available for the luminaire upon request.

736-2.04 Vertically Mounted LED Luminaries:

Vertically mounted LED luminaries shall meet the requirements of Subsection 736-2.01 of the specifications and as specified herein. Vertically mounted luminaire shall be a pole-top-type fixture and shall be mounted with a vertical slip fitter, designed to illuminate roadways from offsets of up to 50 feet.

(A) Luminaire Housing:

The luminaire housing shall have a hinged, removable door.

The maximum weight for the high mast fixture when fully assembled shall not exceed 55 pounds.

The luminaire housing shall have a maximum EPA of no more than 3.5 square feet when tilted 45 degrees.

The luminaire housing shall be equipped with a seven-pin PECR conforming to ANSI Standard C136.10, and shall be provided with a shorting cap.

(B) Mounting:

The luminaire housing shall have a slip fitter mounting on nominal 1-1/2 inch (1-2/3 inch outside diameter) to 2-1/2 inch (2-7/8 inch outside diameter) by 5 inch pipe (Tenon); provided with stainless or zinc plated clamps fixed by four 2 inch by 3/8 inch zinc plated hexagonal bolts with spring washers.

The slip fitter mounting shall be equipped with a swivel joint support that enables tilting the fixture from 0 degrees to 45 degrees supplied with tilt angle indicator to enable correct aiming.

(C) Electrical Requirements:

The terminal block shall be 3-station, tunnel lug terminal board that will accommodate AWG #6 thru #12.

(D) Optical Requirements:

At horizontal position, 0 degree tilt angle, the luminaire shall have zero up light.

Optional shields shall be available for the luminaire upon request; the shields shall be mountable to sides, front and back of the fixture.

736-2.05 Underdeck Diode LED Luminaries:

Underdeck diode LED luminaries shall meet the requirements of Subsection 736-2.01 of the specifications and as specified herein. The luminaries shall be LED, specifically engineered and designed by the manufacturer for ceiling or wall mount type applications for underdeck lighting that is purposed to operate during dark hours. Luminaries shall be submitted to and reviewed by the Engineer prior to approval for use on the project. The contractor shall allow sufficient time for review and approval.

(A) Luminaire Housing:

The luminaire housing shall have glass lens and hinged, removable door that opens downward to allow access to electronic components and terminal block. The door shall be secured to prevent accidental opening or dropping.

The underdeck luminaire housing shall be painted bronze or dark bronze.

Maximum luminaire weight shall not exceed 50 pounds.

(B) Mounting:

The luminaire housing shall be designed to mount directly on a wall or ceiling for surface wiring or over a recessed outlet box for embedded wiring. All mounting hardware shall be made from corrosion resistant material. Grommets shall be installed for all cable entry holes.

(C) Electrical Requirements:

The terminal block shall be 3-station, tunnel lug terminal board that will accommodate AWG #6 thru #12.

736-2.06 Lighting Controls:

(A) Photo Electric Controls

The photo electric controls, hereinafter referred to as PEC, shall comply with the electrical requirements specified in the standard drawings.

The nominal dimensions shall be as shown on the standard drawings. The operating temperature range shall be from -40 to +158 degrees F with zero to 100 percent relative humidity. A time delay shall be incorporated into the circuit to prevent the lights from being turned off at night by transient lights which might be focused on the control. The PEC shall be a conventional glass faced, hermetically sealed cell.

A switch to permit manual operation of the lighting circuit shall be provided for each PEC.

The PEC shall work in conjunction with an external auxiliary load relay for handling the required lighting loads unless specified otherwise.

The PEC shall have a built-in lightning arrester and inrush current protection. The encapsulated surge protector shall have a spark-over value of 2 kilovolts and shall interrupt up to 10 kiloamperes of follow-through current without affecting the operating characteristics.

Voltage Rating:	120 to 277 volts AC, 60 hertz
Load Rating:	8 A LED
Turn on:	1.5, ±0.5 foot candles.
Turn off:	2.25 foot candles
Time delay:	2 to 5 Seconds
Fail Mode:	ON
Power Consumption:	Less than 0.65 W
Water ingress protection:	NEMA 3, raintight
Life rated at full load:	No less than 10,000 On-Off operations.

Regulatory Listings shall include:

ANSI C131.10 and RoHS compliant;
UL 773 certified; and
Tested to NEMA 410 LED Load Standards.

(B) Auxiliary Contactor

Unless otherwise specified, an auxiliary contactor shall be used in conjunction with a PEC to control the required lighting loads. The contactor shall have contacts rated to switch the specified lighting loads and shall be normally open. The contactor shall be single-pole or double-pole as required. The contactor shall be installed as shown on the plans.

(C) Manual-Off-Photo Switch:

A manual-off-photo switch shall be installed, as shown on the Standard Drawing to manually activate the contactor to turn the lights on or off. The switch shall be the toggle-type having double-pole, double-throw contacts with the center position being the "off" position, and be rated at 10 amperes at 250 volts A.C. The switch shall be manually activated in the up position and shall be activated by the PEC in the down position.

736-2.07 Load Center Cabinets:

Load Center cabinets, including pole mounted cabinets shall have photoelectric controls and shall also include a concrete foundation, conduit stub-outs, meter socket, rigid metal conduit riser, cabinet housing, panel, breakers, contactor, selection switch, fuses, dry transformer, internal wiring and other incidentals in accordance with the project plans and these specifications.

The load center cabinet housing shall be of NEMA 3R weather resistant construction and UL 508 listed. The cabinet and doors shall be made from ⅛ inch thick, 5052-H32 aluminum with mill finish. All exterior cabinets shall have continuous welding and be free of burrs. The cabinet top shall be sloped to prevent water accumulation; and shall be constructed to allow proper ventilation and be equipped with a washable or replaceable air filter. Doors shall be attached using continuous hinges, equipped Corbin locks, and keyed #2 with two keys. Doors shall also be equipped with two position door stops, three-point door latch with rollers for top and bottom strikes and pad-lockable handles.

Circuit breakers shall be molded case, thermal magnetic, bolt-on or plug-in type and shall be U.L. listed.

Load center cabinets shall have a dead front panel to isolate all live electrical circuitry. The panel shall be fabricated from aluminum sheeting and shall be painted the same as the cabinet. The dead front panels shall be hinged on one side and securely fastened on the other with bolts. Switches, breakers and other components shall have openings to operate from the front panel.

736-3 Construction Requirements:

Each LED light shall be installed as a complete unit.

The contractor shall maintain full nighttime operation of the existing lighting system during the duration of the construction project, unless otherwise approved by the Engineer.

736-4 Method of Measurement:

Luminaires will be measured as a unit for each luminaire furnished, installed, and operational.

Load center cabinets will be measured as a unit for each load center cabinet furnished and installed.

736-5 Basis of Payment:

The accepted quantities of luminaires and load center cabinets, measured as provided above, will be paid for at the contract unit price each, for the types of luminaires and load center cabinets designated in the bidding schedule, complete in place, which price shall be full compensation for the work described and specified herein and on the plans.

SECTION 737 INCIDENTAL ELECTRICAL WORK:

737-1 Description:

The work under this section shall consist of maintaining existing traffic signals and lighting systems, furnishing and installing complete and functioning temporary traffic signal systems, removing and salvaging or reinstalling electrical equipment, and preparing updated electrical record drawings of all installed electrical equipment; all in accordance with the project plans and the requirements of these specifications.

737-2 Materials:

737-2.01 Maintaining Existing Traffic Signals and Lighting Systems:

Replacement items necessary for maintaining existing Traffic Signal and Lighting Systems shall be of similar make and manufacture and meet the minimum material requirements of those items they are to replace.

737-2.02 Temporary Traffic Signals:

(A) General:

Department approved pole-line hardware shall be utilized in the installation of poles, messenger cable, pole anchors, etc.

(B) Wood Poles:

Wood poles shall be 35 feet in length, Class 3, unless otherwise specified, and meet the requirements of Section 731 of the specifications. Holes for poles shall be dug at an angle with the vertical to allow for proper raking of the top of the pole. Poles shall be set 6 feet deep in the ground, be well tamped, and raked 1 foot out from the vertical position and in line with the pull of the cable.

The wood poles for temporary signals and their associated cables, wires, supports, etc. shall be located so as to provide clearance for all permanent construction.

(C) Messenger Cable:

The messenger cable used for aerial signals and anchoring shall be 3/8-inch minimum, seven-strand, high-strength grade, galvanized steel messenger cable securely attached to the poles and anchors in an approved manner.

(D) Department Furnished Material:

The Department will be responsible for any changes required in the control cabinet. The existing pedestrian units shall be used on the temporary traffic signals. The existing controller cabinet shall be used. All other equipment and materials necessary for the temporary signals shall be furnished by the contractor.

737-2.03 Removing and Salvaging or Reinstalling Electrical Equipment:

Replacement parts for salvaged or reinstalled electrical equipment shall meet the material requirements for like items as hereinbefore specified, as directed by the Engineer, or as designated in the Special Provisions.

737-3 Construction:

737-3.01 Maintaining Existing Traffic Signals and Lighting Systems:

All existing traffic signal and lighting systems or other designated electrical systems, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. The work shall also include the relocation and/or modification of existing traffic signals and lighting systems as required during construction.

The traffic signal system shutdowns shall be limited to the normal working hours as directed by the Engineer. During periods of shutdown, flaggers shall be employed to manually direct traffic. At all other times, the traffic signal system shall remain operational.

All traffic signal heads not in use shall be covered with burlap and shall be unmistakably out of service when observed by an approaching driver. Plastic coverings shall not be allowed.

During construction, the maintenance, care and control of the existing traffic signal control cabinet will be the responsibility of the Department

or the local agency. All other maintenance of the existing traffic signal system shall be accomplished by the contractor.

The contractor shall maintain full nighttime operation of the existing lighting system for the duration of the construction project. The contractor shall designate a person who will be available for emergency maintenance calls after normal working hours. The contractor shall furnish this person's name and telephone number to the Engineer. The contractor shall have labor and the necessary equipment available on a 24-hour per day basis for such emergency maintenance.

737-3.02 Temporary Traffic Signals:

Messenger cable shall have a maximum sag of 5 percent of the distance of spans. The lowest point of any back plate shall initially be 17 feet above the roadway to allow for settling of poles and anchors. Backplates shall be maintained so that the clearance between the lowest point of any backplate and the future finished roadway grade shall be not less than 16 feet. The contractor shall check each day to insure that the minimum clearance is maintained and shall take corrective measures if necessary.

Cable rings on 24-inch maximum spacing shall be used to secure the signal wires to the messenger cable. The wires shall also be taped to the cable if necessary to prevent excessive and unsightly slack in the line(s).

The continuous operation of traffic signals shall be in accordance with the requirements of Subsection 737-3.01 of the specifications.

The contractor shall maintain the electrical systems for the duration of the construction project. The contractor shall designate a person who will be available for emergency maintenance calls after normal working hours. The contractor shall furnish this person's name and telephone number to the Engineer. The contractor shall have labor and the necessary equipment available on a 24-hour per day basis for such emergency maintenance.

When required, the contractor shall remove and salvage all material associated with the temporary traffic signal. All salvaged material shall be the property of the Department and shall be dismantled and stockpiled as directed by the Engineer. Material broken or damaged by the contractor shall be replaced with new and like material at no additional cost to the Department. It shall be the responsibility of the contractor to remove and dispose of all traffic signal equipment and materials not salvaged.

Cavities resulting from the removal of pull boxes, foundations or other material shall be backfilled and compacted with material equivalent to or better than the surrounding material.

737-3.03 Removing and Salvaging or Reinstalling Electrical Equipment:

The contractor shall remove and salvage all existing traffic signal and lighting equipment as specified in the Special Provisions, project plans, or as directed by the Engineer. The work shall also include the removal and disposal of foundations. All equipment and materials to be salvaged shall be the property of the Department. Salvageable material shall be dismantled and stockpiled, prior to project completion, as directed by the Engineer or as shown on the plans.

All equipment damaged or destroyed by improper care or handling shall be replaced with new equipment. Unless otherwise specified, it shall be the responsibility of the contractor to remove and dispose of all discarded materials not salvaged. Holes resulting from removal of pull boxes, foundations, and other material shall be backfilled and compacted with material equivalent to the surrounding area or as designated by the Engineer.

When salvaged equipment is to be reinstalled, the contractor shall furnish and install all necessary materials, equipment, and hardware as required to complete the new installation. Reinstalled poles, pull boxes and cabinets shall be relocated as shown on the plans, with conduit and conductors installed, and all circuit connections complete and operational. Signal faces, mounting assemblies and backplates shall be cleaned and repainted when reinstalled. All traffic signal faces, either to be reinstalled or part of a modified system, shall be relamped. Luminaires to be reinstalled shall be cleaned and relamped.

Existing materials to be relocated and found to be unsatisfactory by the Engineer shall be replaced with new material and will be paid for in accordance with the requirements of Subsection 109.04 of the specifications.

737-3.04 Electrical Record Drawings:

The contractor shall prepare, update, and provide a set of electrical record drawings, which show the actual as-built conditions of all installed electrical components that have been approved by the Engineer.

The contractor shall prepare and submit the electrical record drawings that incorporate all revisions and modifications to the Engineer for approval. The contractor shall sign and indicate the date the electrical record drawings are prepared on the face sheet. The contractor's signature on the title page shall certify that the drawings are complete and correct.

Dimensions and electrical item revisions that deviate from the original plan sheets shall be represented in red to the satisfaction of the Engineer.

Dimensioning for Electrical Underground Materials shall conform to measurement limits outlined within Subsection 732-4 of the specifications, including offsets taken from the edge of pavement. All pull boxes and foundations shall indicate station number and offsets measured from the edge of pavement.

The contractor shall determine the as-built location for all existing and new traffic signal and lighting pull boxes based on station, offset from edge of pavement, milepost, and differential GPS measured latitude and longitude. Loop detectors shall be dimensioned from edge of pavement to center of loop with station number at the front of the loop. Loop tail conduits should be dimensioned from pull box to end of conduit showing length and direction.

Electrical Record Drawings shall include all maintenance unit number decals installed on each electrical component, as specified in Subsection 730-7 of the specifications.

The plans for conductor and pole schedule shall reflect all changes made, such as number of conductors, size of conductors or circuit number.

All electrical record drawings shall be electronically produced in a format that allows for reproduction in both 11 by 17 inch and 34 by 22 inch sizes. The Engineer will accept the work upon ones approval of all the electronic record drawings. The contractor shall provide an electronic copy of the record drawings in a suitable reproducible format to the Engineer for distribution.

737-4 Method of Measurement:

Maintaining existing traffic signals and lighting systems will be measured as a single, complete unit of work.

Temporary Traffic Signal will be measured as a single, complete unit of work.

Removing and salvaging or reinstalling electrical equipment will be measured as a single, complete unit of work.

Electrical record drawings will be measured on a lump sum basis.

737-5 Basis of Payment:

The accepted quantities of maintaining existing traffic signals and lighting systems, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete, as specified and described herein, and as shown on the project plans.

The accepted quantities of Temporary Traffic Signal, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place, as specified and described herein, and as shown on the project plans.

The accepted quantities of removing and salvaging or reinstalling electrical equipment, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place, as specified and described herein, and as shown on the project plans.

The accepted quantity of electrical record drawings, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place.

SECTION 801 LANDSCAPE EXCAVATION:

801-1 Description:

The work under this section shall consist of excavating areas to be landscaped, hauling, and satisfactory disposal of surplus excavated material, in accordance with the details shown on the project plans and the requirements of these specifications.

801-2 BLANK:

801-3 Construction Requirements:

All landscape excavation shall be performed in reasonably close conformity to the lines, grades, dimensions and cross sections established by the Engineer or shown on the project plans.

The hauling and disposal of surplus excavated material shall be in accordance with the requirements of Subsection 203-3.03(E) of the specifications.

801-4 Method of Measurement:

Landscape excavation will be measured either by the cubic yard or by the ton.

Landscape excavation measured by the cubic yard will be measured in its original position by the Engineer, and the volume will be computed by the average end area method or by other methods approved by the Engineer.

Landscape excavation measured by the ton will be measured in accordance with the requirements of Subsection 109.01 of the specifications.

801-5 Basis of Payment:

The accepted quantities of landscape excavation, measured as provided above, will be paid for at the contract unit price per cubic yard or per ton for the pay unit designated in the bidding schedule.

SECTION 802 LANDSCAPE GRADING:

802-1 Description:

The work under this section shall consist of grading, contouring, smoothing or otherwise shaping areas at the locations designated on the project plans.

802-2 BLANK:

802-3 Construction Requirements:

Roadway shoulders and soil areas left exposed after planting shall be graded as required to leave a generally smooth appearance conforming to the general shape and cross section indicated on the project plans. The final surfaces shall be raked smooth. All objectionable material, trash, brush, weeds and stones larger than 2 inches in diameter shall be removed from the site and disposed of in a manner acceptable to the Engineer.

802-4 Method of Measurement:

Landscape grading will be measured either by the square yard of area actually graded or as a single complete unit of work.

802-5 Basis of Payment:

The accepted quantities of landscape grading, measured as provided above, will be paid for at the contract unit price per square yard or per lump sum for the pay unit designated in the bidding schedule.

When landscape grading is not included as a contract item, full compensation for any landscape grading necessary to perform the construction operations specified on the project plans and in the Special Provisions will be considered as included in the unit price paid for contract items.

SECTION 803 LANDSCAPE PLATING MATERIALS:

803-1 Description:

The work under this section shall consist of grading surfaces, eradicating grasses, weeds and undesirable vegetation, furnishing, hauling, placing and compacting imported materials for plating embankment slopes, dikes and other designated areas, all in accordance with the details shown on the project plans and the requirements of these specifications.

803-2 Materials:

803-2.01 Soil Backfill and Plating Material:

Soil backfill and plating material shall be secured from commercial sources or from contractor furnished sources unless otherwise designated in the Special Provisions. The material shall conform to the requirements of Subsection 804-2 of the specifications.

803-2.02 Decomposed Granite and Granite Mulch:

Decomposed granite and granite mulch shall be free of lumps or balls of clay and shall not contain calcareous coatings, caliche, organic matter or foreign substances. All material shall be from a single production source and shall present a uniform appearance throughout the project. The gradation of the decomposed granite shall be as specified in the Special Provisions.

803-2.03 Rock Mulch:

Rock mulch shall be free of calcareous coating, caliche, organic matter or other foreign substances.

803-3 Construction Requirements:

803-3.01 Soil Backfill and Plating Material:

Areas to receive soil backfill and plating material shall be cleared of all undesirable vegetation, brush, trash, or rock which is 2 inches in diameter or larger, and other objectionable material as directed by the Engineer. Undesirable vegetation, grasses and weeds shall be eradicated with an approved herbicide and by mechanical methods.

The soil backfill and plating material shall be spread and shaped to conform to the lines, grades and cross sections shown on the project plans or as established by the Engineer. The material shall be watered and compacted as specified in the Special Provisions.

803-3.02 Decomposed Granite and Granite Mulch:

Decomposed granite or granite mulch shall not be placed until the required water distribution systems, acceptable finished grading, and planting operations have been completed within the area.

The surfaces and planting areas upon which decomposed granite or granite mulch is to be placed shall be graded and compacted to a density of 85 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. Areas which shall not be compacted will be designated by the Engineer.

The areas on which decomposed granite or granite mulch is to be placed shall be reasonably smooth and firm and all deleterious material and rocks larger than 1-1/4 inches in diameter shall be removed and disposed of by the contractor.

Decomposed granite or granite mulch shall be evenly distributed over the designated areas. The depth of the decomposed granite or granite mulch shall be within 1/2 inch of the depth shown on the project plans.

All areas to receive decomposed granite or granite mulch shall be as approved by the Engineer prior to placement of the decomposed granite or granite mulch.

All vehicles used for spreading, grading, and raking the granite mulch and decomposed granite shall have one set of wheels with floatation tires having a minimum width of 18 inches to allow equal compaction of the granite mulch and decomposed granite.

After rough spreading and rough grading of the granite mulch and decomposed granite within the designated areas, the granite mulch and decomposed granite shall be raked to evenly blend the different gradation sizes. Following approval by the Engineer, the granite mulch and decomposed granite shall be saturated with water to optimum moisture level. The Engineer will approve the amount of water necessary to aid in the compaction of the granite mulch and decomposed granite.

Where granite mulch and decomposed granite are within the planting pits, the maximum depth shall be 1 inch.

During the final spreading and final grading operations, all surfaces within the granite mulch and decomposed granite areas shall be passed over by the spreading and grading equipment a minimum of two times. All equipment operations for spreading and grading, raking, chemical application, water settling, and any other operations shall be done in a manner that uniformly maximizes the vehicles' wheel compaction over the surface.

The contractor shall apply one application of an approved pre-emergent herbicide on all granite areas following placement of the granite. Water to activate the pre-emergent herbicide shall be applied to the areas of the herbicide application as recommended by the manufacturer's label. The amount of water specified by the manufacturer may be adjusted due to rainfall, if approved by the Engineer.

The contractor shall notify the Engineer and obtain prior approval for the use of any herbicides for weed eradication. The contractor shall keep a record of all applications; the type of herbicides used; the rate and method of application; and the date and location of such applications. A copy of this record shall be submitted to the Engineer after each application.

After placing, spreading and grading the granite, the contractor shall water settle the total thickness of the granite to remove the fine material from the surface.

Any erosion which occurs within the decomposed granite and granite mulch areas shall be corrected by the contractor and approved by the Engineer prior to final acceptance.

803-3.03 Rock Mulch:

The surfaces upon which the rock mulch is to be placed shall be fine graded and compacted to 90 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. All deleterious material shall be removed and disposed of by the contractor. The areas shall be totally free of grasses, weeds and undesirable vegetation, using herbicides in accordance with Subsection 803-3.02 of the specifications. All dead grass and weeds shall be removed and disposed of by the contractor as approved by the Engineer. The contractor shall repair eroded areas and compact soil as approved by the Engineer.

Prior to placement of rock mulch, the contractor shall stake out all areas to receive rock mulch and a pre-emergent herbicide shall be applied to the staked areas in accordance with the manufacturer's printed instructions and as approved by the Engineer. Water shall be applied to the areas of the herbicide application as required by the manufacturer's label. This water may be supplemented by rainfall as determined by the Engineer.

The rock shall be placed in an even application, tightly packed, to provide complete coverage of the area shown on the project plans so that soil will not be visible between rocks.

After placing and grading the rock mulch, the contractor shall water the mulch with a light spray to remove fine material from the surface as approved by the Engineer. Any regrading that is necessary after placement of the rock mulch shall be at no additional cost to the Department.

Care shall be taken in the placement of the rock mulch so as not to disturb or damage any plant material, adjacent surfaces or irrigation equipment.

803-4 Method of Measurement:

Decomposed granite and granite mulch will be measured by the square yard, or by the cubic yard, of material in place at the specified thickness. The quantity for this item, as shown on the bidding schedule, will be used for payment of this item unless the contractor and the Engineer agree that there is a variation in excess of 10 percent. The Engineer will determine the new quantities for variations in excess of 10 percent.

Rock mulch will be measured by the cubic yard of material in place at the specified thickness. The quantity for this item, as shown on the bidding schedule, will be used for payment of this item unless the contractor and the Engineer agree that there is a variation in excess of 10 percent. The Engineer will determine the new quantities for variations in excess of 10 percent.

Soil backfill and plating material (landscape borrow) will be measured either by the cubic yard or by the ton.

Soil backfill and plating material (landscape borrow) measured by the cubic yard will be measured in its original position by the Engineer, and the volume will be computed by the average end area method or by other methods approved by the Engineer.

Soil backfill and plating material (landscape borrow) measured by the ton will be measured in accordance with the requirements of Subsection 109.01 of the specifications. The weight of the material will be determined by deducting the difference in weight between the average in-place moisture content of the material prior to any prewetting in accordance with the requirements of Subsection 206-3 of the specifications and the average moisture content of the material at the time of weighing.

803-5 Basis of Payment:

The accepted quantities of landscape borrow, decomposed granite, granite mulch and rock mulch, measured as provided above, complete in place, will be paid for at the contract unit price for the pay unit designated in the bidding schedule. No direct payment will be made for the eradication of grasses, weeds and undesirable vegetation; herbicide material applied in excess of the specified thickness; or erosion repair work; the cost being considered as part of contract items.

SECTION 804 TOPSOIL:

804-1 Description:

The work under this section shall consist of furnishing, hauling and placing topsoil in accordance with the details shown on the project plans and the requirements of these specifications.

804-2 Materials:

When a source of topsoil is not designated, the contractor shall furnish a source in accordance with the requirements of Section 1001 of the specifications. Topsoil from sources furnished by the contractor shall conform to the following requirements:

Prior to hauling any topsoil to the project site, the contractor shall furnish a written soil analysis, prepared by a laboratory approved by the Engineer, for each source of topsoil proposed for use. The soil analysis shall indicate the pH, soluble salts, percent calcium carbonate, exchangeable sodium in percent and parts per million, plasticity index and size gradation. A minimum of three samples per each 10,000 cubic yards, with at least three samples per source, shall be tested. All tests shall be performed in accordance with the following requirements and

test procedures listed in Table 804-1. At the contractor's option, the Engineer will test these topsoil samples. The contractor shall bear the expense of any topsoil testing from proposed sources.

Topsoil shall be fertile, friable soil obtained from well drained arable land which has or is producing healthy crops, grasses or other vegetation. It shall be free draining, non-toxic and capable of sustaining healthy plant growth.

Topsoil shall be reasonably free of subsoil, refuse, roots, heavy clay, clods, noxious weed seeds, phytotoxic materials, coarse sand, large rocks, sticks, brush, litter and other deleterious substances.

A written soil analysis shall be submitted to the Engineer for each source of topsoil proposed for use. The Engineer's approval shall be obtained prior to delivery of topsoil to the project site from each source.

For acceptance purposes, each approximate 20,000 cubic yards of topsoil material delivered from a given source to the project site shall be considered a lot. For each lot of topsoil, six representative samples shall be taken at random locations designated by the Engineer. Topsoil shall be sampled after final placement. Each source of topsoil shall be tested separately. The samples from each lot shall be tested by the Engineer for pH, soluble salts, calcium carbonate, exchangeable sodium in percentage and parts per million, P.I., and gradation in accordance with the test procedures listed in Table 804-1.

The average test result obtained for each characteristic from each lot shall meet the following requirements.

TABLE 804-1

Characteristics	Test Method	Requirement Average of 6 Samples
pH	Arizona Test Method 237	6.0 - 8.3
Soluble Salts: (PPM)	Arizona Test Method 237	2000 Maximum
Calcium Carbonate:	Arizona Test Method 732	8% Maximum
Exchangeable Sodium:	Arizona Test Method 729	5% Maximum
Exchangeable Sodium: (PPM)	Arizona Test Method 729	300 Maximum
P.I.	AASHTO T 90	5 - 20
Gradation: 2 inch 1/2 inch No. 40	AASHTO T 11, T 27	% Passing 100 85 - 100 35 - 100

If the average test result for a lot fails to meet all the specifications listed above, the material from that lot shall be rejected. In lieu of removal and replacement, the contractor may propose for the Engineer's consideration a method of treatment of the in-place material to obtain specification compliance. Provided the Engineer approves, the topsoil shall be treated at no additional cost to the Department. The lot shall then be resampled and tested for specification compliance by the Engineer.

If the pH of the topsoil for a lot exceeds 8.3, the topsoil shall either be removed and replaced, or be treated as provided for in the preceding paragraph. Any treatment for pH shall be sufficient to obtain an average pH between 6.0 and 8.0, inclusive. The treatment for pH shall follow the recommendations of a recognized soil analyst and shall be subject to the approval of the Engineer. Any treatment for pH shall be at no additional cost to the Department. Additional acceptance testing after treatment for pH will not be required.

804-3 Construction Requirements:

Topsoil shall be spread uniformly on the designated areas to the depths or contours shown on the plans. The contractor shall avoid over-compaction in spreading and shaping operations. Scarification shall be required for over-compacted areas and haul roads. When topsoil is placed over subgrade material as plating, the subgrade shall be scarified or disked to a 6-inch depth prior to placement of the topsoil.

804-4 Method of Measurement:

Topsoil will be measured by the cubic yard.

Topsoil will be measured in its final position, and the volume will be computed by the average end area method or by other methods approved by the Engineer.

804-5 Basis of Payment:

The accepted quantities of topsoil, measured as provided above, will be paid for at the contract unit price per cubic yard, complete in place.

SECTION 805 SEEDING:

805-1 Description:

The work under this section shall consist of furnishing all materials, preparing the soil and applying seed to all areas designated on the project plans or established by the Engineer. Seeding shall be Class I, Class II or Class III, and shall be performed in accordance with the project plans and requirements of these specifications.

805-2 Materials:

805-2.01 General:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

805-2.02 Seed:

The species, strain or origin of seed shall be as designated in the Special Provisions.

No substitution of species, strain or origin of seed will be allowed unless evidence is submitted in writing by the contractor to the Engineer showing that the specified materials are not reasonably available during the contract period. The substitution of species, strains or origins shall be made only with the written approval of the Engineer, prior to making said substitution.

The seed shall be delivered to the project site in standard, sealed, undamaged containers. Each container shall be labeled in accordance with A.R.S. and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act. Labels shall indicate the variety or strain of seed, the percentage of germination, purity and weed content, and the date of analysis which shall not be more than nine months prior to the delivery date.

Legume seed shall be inoculated with appropriate bacteria cultures approved by the Engineer, in accordance with the culture manufacturers' instructions.

805-2.03 Mulch:

(A) General:

The type and application rate of mulch shall be as specified in the Special Provisions.

(B) Manure:

Manure shall be steer manure that has been well composted and unleached, and which has been collected from cattle feeder operations. Manure shall be free of sticks, stones, earth, weed seed, substances injurious or toxic to plant growth and visible amounts of under composted straw or bedding material. Manure shall not contain lumps or any foreign substance that will not pass a 1/2-inch screen and, when specified for lawn use, the material shall be ground or screened so as to pass a 1/4-inch screen.

(C) Peat Humus:

Peat humus shall be natural domestic peat of peat humus from fresh water saturated areas, consisting of sedge, sphagnum or reed peat and shall be of such physical condition that it will pass through a 1/2-inch screen. The humus shall be free of sticks, stones, roots and other objectionable materials.

Peat humus shall have a pH value between 4.0 and 7.5, inclusive, and the minimum organic content shall be 85 percent of the dry weight. The ash content, as determined by igniting a 5 gram sample for 20 hours at a temperature of 900 degrees F, shall not exceed 25 percent by weight.

Peat humus shall be furnished in undamaged commercial bales in an air-dry condition.

(D) Wood Cellulose Fibers:

Natural wood cellulose fiber shall have the property of dispersing readily in water and shall have no toxic effect when combined with seed or other materials. A colored dye which is noninjurious to plant growth may be used. Wood cellulose fiber shall be delivered in undamaged, labeled containers bearing the name of the manufacturer and showing the air-dry water content.

(E) Straw:

Straw shall be from crops of current season as approved by the Engineer and shall be free of noxious weeds, mold or other objectionable material. Straw mulch shall be in an air-dry condition and suitable for placing with mulch blower equipment.

805-2.04 Water:

Water shall be free of oil, acid, salts or other substances which are harmful to plants. The source shall be as approved by the Engineer prior to use.

805-2.05 Tacking Agent:

Tacking agent shall be as specified in the Special Provisions.

805-2.06 Chemical Fertilizer:

Chemical fertilizer shall be a standard commercial fertilizer conforming to the analysis and in the physical form specified in the Special Provisions. Chemical fertilizer shall be furnished in standard containers or bags with the name, weight and guaranteed analysis of the contents clearly marked. When a mixed fertilizer is specified, such as 24-18-2, the first number shall represent the minimum percent of soluble nitrogen,

the second number shall represent the minimum percent of available phosphoric acid and the third number shall represent the minimum percent of water soluble potash.

805-3 Construction Requirements:

805-3.01 General:

Seed shall be of the class and variety specified, and shall be applied at the rate specified in the Special Provisions.

The contractor shall notify the Engineer at least two days prior to commencing seeding operations.

Bermuda seed shall be planted only at times when the daytime atmospheric temperatures are consistently above 90 degrees F and the nighttime atmospheric temperatures are consistently above 60 degrees F.

Seeding operations shall not be performed when wind would prevent uniform application of materials or would carry seeding materials into areas not designated to be seeded.

Preparation of areas for seeding shall be as specified herein and in the Special Provisions.

The equipment and methods used to distribute seeding materials shall be such as to provide an even and uniform application of seed, mulch and/or other materials at the specified rates.

Unless specified otherwise in the Special Provisions, seeding operations shall not be performed on undisturbed soil outside the clearing and grubbing limits of the project or on steep rock cuts.

805-3.02 Classes of Seeding:

(A) Seeding (Class I):

Seeding (Class I) shall consist of furnishing and planting lawn seed.

Immediately before seeding, the surface area shall be raked or otherwise loosened to obtain a smooth friable surface free of earth clods, humps and depressions. Loose stones having a dimension greater than 1 inch and debris brought to the surface during cultivation shall be removed and disposed of by the contractor in a manner approved by the Engineer.

Where indicated on the project plans or specified in the Special Provisions, topsoil shall be placed and allowed to settle for at least one week prior to seeding. The topsoil shall be thoroughly watered at least twice during the settlement period.

Seed shall be uniformly applied in two directions at right angles to each other with one-half the specified application rate applied in each direction.

Immediately after seeding, the area shall be uniformly covered with screened manure at the rate of 1 cubic yard per 1,000 square feet and then watered until the ground is wet to a minimum depth of 2 inches.

Hydroseeding (hydraulic seeding), using 1,500 pounds of wood cellulose fiber per acre, will be an acceptable alternate for planting and mulching Seeding (Class I).

Machines used for hydroseeding shall be approved types capable of continuous agitation of the slurry mixture during the seeding operation. Pump pressure shall be such as to maintain a continuous nonfluctuating spray capable of reaching the extremities of the seeding area with the pump unit located on the roadbed. The sprayer shall be equipped to use the proper type of nozzles to obtain a uniform application on the various slopes at the distance to be covered.

The seed, fertilizer, mulch, tacking agent (when required) and water shall be combined in the proportions of the various materials as provided in the Special Provisions and allowed to mix a minimum of five minutes prior to starting the application of the slurry. Seed shall be applied within 30 minutes after mixing with water.

Hydroseeding which is deposited on adjacent trees and shrubs, roadways, in drain ditches, on structures and upon any areas where seeding is not specified or which is placed in excessive depths on seeding areas shall be removed.

Seeding areas flooded or eroded as a result of irrigation shall be repaired, reseeded and refertilized by the contractor, at no expense to the Department.

(B) Seeding (Class II):

Seeding (Class II) shall consist of furnishing and planting range grass seed, flower seed and/or shrub seed, including mulch.

Where equipment can operate, the area to be seeded shall be prepared by disking, harrowing or by other approved methods of loosening the surface soil to the depth specified in the Special Provisions. On slopes too steep for equipment to operate, the area shall be prepared by hand raking to the specified depth. On sloping areas, all disking, harrowing and raking shall be directional along the contours of the areas involved. Loose stones having a dimension greater than 4 inches which are brought to the surface during cultivation shall be removed and disposed of in an approved manner prior to grading and seeding. All areas which are eroded shall be restored to the specified condition, grade and slope as directed prior to seeding.

On cut and fill slopes the operations shall be conducted in such a manner as to form minor ridges thereon to assist in retarding erosion and favor germination of the seed.

Care shall be taken during the seeding operations to prevent damage to existing trees and shrubs in the seeding area in accordance with the requirements of Subsection 107.11 of the specifications. Seed shall be drilled, broadcast or otherwise planted in the manner and at the rate specified in the Special Provisions.

The type of mulch, and the manner and rate of application shall be as specified in the Special Provisions.

Mulch material which is placed upon trees and shrubs, roadways, structures and upon any areas where mulching is not specified or which is placed in excessive depths on mulching areas shall be removed as directed. Mulch materials which are deposited in a matted condition shall be loosened and uniformly spread, to the specified depth, over the mulching areas.

During seeding and mulching operations, care shall be exercised to prevent drift and displacement of materials. Any unevenness in materials shall be immediately corrected by the contractor.

Mulch shall be immediately affixed by crimping and tacking after application. The Engineer shall determine which areas are not conducive to anchoring by crimping and will direct the contractor to anchor such mulch by tacking only. No mulch shall be applied to seeding areas which can not be crimped and/or tacked by the end of each day. Any drifting or displacement of mulch before crimping and/or tacking shall be corrected by the contractor, at no additional cost to the Department.

If a tacking agent is specified in order to bind the mulch in place, the type, rate and manner of application shall be as specified in the Special Provisions. Prior to the application of a tacking agent, protective covering shall be placed on all structures and objects where stains would be objectionable. All necessary precautions shall be taken to protect the traveling public and vehicles from damage due to drifting spray.

Unless otherwise specified in the Special Provisions, Class II seeding areas shall not be watered after planting.

(C) Seeding (Class III):

Seeding (Class III) shall consist of furnishing and planting range grass seed, flower seed and/or shrub seed, all without mulching.

Seeding (Class III) shall conform to the requirements specified under Subsection 805-3.02(B) of the specifications, except that mulching will not be required.

Unless otherwise specified in the Special Provisions, Class III seeded areas shall not be watered after planting.

805-3.03 Preservation of Seeded Areas:

The contractor shall protect seeded areas from damage by traffic or construction equipment. Surfaces which are eroded or otherwise damaged following seeding and prior to final acceptance shall be repaired by regrading, reseeding and remulching as directed by the Engineer.

805-4 Method of Measurement:

Seeding (Class I) will be measured by the square foot of ground surface measured to the nearest 1,000 square feet seeded or as a single complete unit of work.

Seeding (Class II) and Seeding (Class III) will be measured by the acre of ground surface seeded or as a single complete unit of work.

805-5 Basis of Payment:

The accepted quantities of seeding, measured as provided above, will be paid for at the contract price for the pay unit specified in the bidding schedule, complete in place.

No direct measurement or payment will be made for the preservation or repairs of seeded areas.

SECTION 806 TREES, SHRUBS, AND PLANTS:

806-1 Description:

The work under this section shall consist of furnishing and planting trees, palms, shrubs, vines, cacti and other plants (nursery stock) and transplanting trees, palms, shrubs, vines, cacti and other plants (collected stock and/or local stock), all as designated on the project plans. The work shall also include the layout and preparation of planting pits, trenches and beds, including excavating and backfilling; the storage and protection of all planted and unplanted stock and other materials; amendments, all mulching, fertilizing, watering, staking, guying, pruning and wrapping; the cleanup of the area; application of pre-emergent herbicide; removal of grass, weed and undesirable vegetation; application of rodent repellent; disposal of unwanted and deleterious materials; and the care and maintenance; all in accordance with the details shown on the project plans and the requirements of these specifications.

806-2 Materials:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted to the Engineer for all contractor furnished materials, unless otherwise specified.

806-2.01 Nursery Stock:

All plants shall be grown in a nursery and shall conform to the applicable requirements specified in the current edition of "American Standard for Nursery Stock" as approved by the American National Standards Institute, Inc., and sponsored by the American Association of Nurserymen, Inc., subject to certain variations in size and measurement when specified on the project plans or in the Special Provisions.

Botanical plant names shall be in accordance with the current edition of "Standardized Plant Names" prepared by the American Joint Committee on Horticultural Nomenclature.

All plants shall be true to type and species shown on the project plans and at least one plant in each group of plants of the same species delivered to the project shall be tagged with a weatherproof label stating both the botanical and common name of the plants in that group.

Within thirty calendar days after the preconstruction conference, the contractor shall supply the Engineer with written verification that it has located and reserved all the plant material necessary to complete the work as specified. This verification will serve as proof of availability for all plant material required.

All plants shall be in a healthy condition with normal symmetrical form, well-developed foliage, branches and cane systems at the time of delivery to the project. Plants shall be free of disease, insect eggs or infestations, disfiguring knots, bark abrasions, broken tops, branches or canes, damaged roots, sun, wind or frost injury, or other objectionable features. Plants pruned from larger sizes to meet specified sizes will not be accepted.

Plants which are furnished in containers shall have been growing in the containers for a sufficient period of time for uniform root development throughout the plants' ball, but the roots shall show no evidence of having been restricted or deformed.

The presence of grass, weeds, or any undesirable organism in the soil surrounding the plants, or any of the previously listed conditions, may be cause for rejection of the plants.

No substitution of species and/or sizes of specified plants shall be made unless evidence is submitted in writing to the Engineer showing that plants in the species, quantity and/or sizes specified are not available during the contract period. The substitution of species and/or sizes shall

be made only with the written approval of the Engineer prior to making said substitution.

Substitution of a larger size of the same species may be made by the contractor without written approval. However, the contractor shall be responsible for any additional cost of the plants or for any additional planting costs.

All plants shall comply with Federal and State laws requiring inspection for diseases and infestations.

All shipments or deliveries of plant material grown within the State will be inspected at the nursery or growing site by the authorized State of Arizona authorities prior to delivery to the project. A copy of the state inspection record shall accompany all plant material which is grown out of state and shall show that the plant material has been inspected for plant diseases and insects.

All rejected plants shall be removed from the project immediately upon rejection by the Engineer.

806-2.02 Collected Stock:

Collected stock shall be secured from sources outside the project limits for transplanting, and shall comply with the size, type and species requirements designated on the project plans or in the Special Provisions. When sources for collected stock are not designated, the contractor shall furnish the source.

Collected stock shall be healthy and free of weeds, grasses, insects, disease, defects and disfigurements, and shall be as approved by the Engineer before transplanting operations are begun. Palm trees shall be free of scars and damage considered unsightly or unhealthy as determined by the Engineer.

The contractor shall comply with all State and Federal laws regarding the removal, sale and transporting of native plants.

806-2.03 Local Stock:

Local stock shall be secured from within the project limits for transplanting and will be designated on the project plans, in the Special Provisions or by the Engineer. All plants shall be as approved by the Engineer before transplanting operations are begun.

806-2.04 Prepared Topsoil:

Prepared topsoil shall consist of prepared soil mixed as specified under Subsection 806-2.05 of the specifications, except the existing soil shall be replaced with topsoil. The existing soil excavated from the planting

pits shall be removed and disposed of by the contractor. Soil conditioner shall be as specified under Subsection 806-2.05 of the specifications.

Topsoil shall conform to the requirements of Subsection 804-2 of the specifications. Soil excavated from existing planting pits, trenches and beds which meet the requirements of Subsection 804-2 of the specifications may be used as topsoil.

806-2.05 Prepared Soil:

Prepared soil shall consist of a uniform mixture of existing soil, peat humus, manure, chemical fertilizer, soil conditioners and/or other needed amendments conforming to the specifications contained herein for the respective items and proportioned as specified in the Special Provisions.

Soil conditioner shall consist of composted, ground or shredded fir, redwood, ponderosa bark or shavings, and shall have a pH not exceeding 7.5, a minimum total nitrogen content of 0.5 percent, an organic matter content of not less than 85 percent, and shall contain a wetting agent or be hygroscopic. The soil conditioner shall be graded so that a minimum of 85 percent of the material will pass a 1/4-inch sieve.

Prepared soil shall be produced prior to use in the planting pits, by combining the approved component materials into a homogeneous uniform mixture. The Engineer shall be notified and shall approve the components and the method of mixing prior to the production of the prepared soil.

806-2.06 Mulch:

Mulch shall conform to the requirements of Subsection 805-2.03 of the specifications.

806-2.07 Water:

Water shall conform to the requirements of Subsection 805-2.04 of the specifications.

806-2.08 Chemical Fertilizer:

Chemical fertilizer shall conform to the requirements of Subsection 805-2.06 of the specifications.

806-2.09 Lumber and Tree-Stakes:

Tree-stakes, supports and braces shall be sound, straight construction grade treated Douglas fir, lodge pole pine, heart redwood or other species approved by the Engineer. Douglas fir stakes and braces shall have nominal dimensions of 2 by 2 inches and lodge pole pine stakes

shall have a diameter of 2 inches or greater. Tree-stakes and braces may be furnished either rough or dressed.

Lumber stored at the project site shall be neatly stacked on skids a minimum of 12 inches above the ground and shall be protected from the elements to prevent damage or warping.

806-2.10 Hardware:

Nails, lag screws, staples and other hardware shall be galvanized and of commercial quality. All bolts and lag screws shall be furnished with galvanized malleable washers.

Wire shall be new soft annealed galvanized steel wire of the size detailed on the project plans.

Covers for guying wires shall be new, 1/2-inch minimum diameter, vinyl or two-ply fabric-bearing rubber hose.

806-2.11 Existing Plant Material:

The contractor shall be responsible for maintaining all existing plants and providing an adequate water supply to any existing plants affected by construction activities. Existing plants that are removed, damaged or destroyed during construction shall be replaced with trees and shrubs of the same species at no additional cost to the Department. Existing plants removed, damaged, or destroyed shall be replaced with plants of a similar size as directed by the Engineer.

806-3 Construction Requirements:

806-3.01 General:

By the time of the preconstruction conference, the contractor shall submit a list of all materials and equipment that it proposes to incorporate into the work to the Engineer electronically. In addition to the electronic submission, the Engineer may request up to three hard copies. The contractor shall have materials and equipment correctly marked on the list. The list shall show the catalog number, manufacturer's name, model numbers, sizes, complete specifications, instructions, design data and/or drawings, to determine whether or not each piece of material or equipment is acceptable and to assure that all such materials and equipment, when incorporated into the work, is in accordance with the requirements of the project plans and these specifications. Plant material shall be approved as specified under Subsection 806-3.03 of the specifications. The contractor's failure to comply with these material submittal instructions will not constitute time extensions.

No material or equipment shall be ordered and work shall not begin until the material and equipment has been approved, in writing, by the Engineer.

All planting shall be done during the times and/or temperatures specified in the Special Provisions.

806-3.02 Excavation:

The contractor shall be responsible for laying out all planting areas and staking all plant locations in reasonably close conformity to the dimensions and locations shown on the project plans. The Engineer's approval of all planting areas and locations shall be obtained prior to any excavating of planting pits, trenches or beds.

In the event that existing field conditions such as subsurface utilities, pipes, structures, impervious materials or inadequate drainage necessitate relocation of planting areas, the Engineer will designate new locations.

Prior to excavating planting pits or trenches or beds for plants, these areas shall be graded to the lines and grades designated on the project plans or as approved by the Engineer.

Planting pits and trenches shall be excavated to the dimensions indicated on the project plans or in the Special Provisions and shall have vertical sides and horizontal bottoms. When dimensions are not specified, the pits and trenches shall be excavated to a depth 12 inches below the bottom of the root system and to a width twice the root system diameter.

When excavation of any planting pit is difficult and the Engineer determines that poor drainage may result, the pit shall be filled with water twice in order to check the drainage. Any pit which has not fully drained after each filling within a twelve-hour period shall be deepened until proper drainage is achieved. If proper drainage cannot be achieved, the pit shall be moved or deleted, as determined by the Engineer. If required, this work shall be paid for in accordance with Subsection 104.02 of the specifications.

Excavation of planting pits, trenches and beds shall not be done when, in the opinion of the Engineer, the moisture content of the soil is excessive with respect to accepted horticultural practice.

806-3.03 Shipping and Handling Plants:

Prior to shipping, all plants shall be dug, handled, prepared and packed for shipment with care and skill, in accordance with recognized standard practice for the kind of plant involved. The root systems of all plants shall not be permitted to dry out at any time. While in transit, plants shall be protected at all times against freezing temperatures, the sun,

the wind and other adverse weather conditions. During transportation in closed vehicles, plants shall receive adequate ventilation to prevent "sweating." Plants delivered in a wilted condition will be rejected.

The contractor shall notify the Engineer at least 24 hours prior to the date for inspection of plants at any Arizona plant source or at the project site. The Engineer will inspect all plants for conformity with the specifications and, upon the Engineer's acceptance, planting may begin. The Engineer may select at random no more than three container-grown plants of each species in every delivery to the site for root development inspection. Plants of the same species from different growers shall be considered as separate shipments. If upon inspection of root development of plants so selected the Engineer determines the roots have become restricted or deformed in their containers, all plants of that species in that shipment, including the inspected plants, will be rejected and shall be removed from the site. The contractor's project supervisor shall attend all plant inspections.

Deciduous plants may be furnished bare-root, and evergreen plants and conifers shall be furnished balled and burlapped or in containers, as specified in the Special Provisions or on the project plans. The balling and burlapping of trees and shrubs shall conform to the recommended specifications set forth in the "American Standard for Nursery Stock." All plant balls shall be firm and intact. Plants whose stems are loose in the ball will be rejected. All balled or burlapped plants shall at all times be handled by the ball and not by the top, leaders or canes.

All bare-root plants delivered in bundles shall have the bundles broken and the plants placed separately prior to being temporarily "heeled-in." Care shall be taken so that all plants removed from bundles will have an identifying label. Bare-root plants shall be stored with roots completely covered with damp sawdust, soil or other suitable moisture-retaining material.

Plants delivered, inspected and found acceptable for planting shall normally be planted within 24 hours after delivery to the project site. Plants which cannot be planted within 24 hours after delivery shall be stored as specified herein.

Balled and burlapped plants shall have the root ball protected by moist sawdust, earth or other acceptable material.

All temporarily stored plants shall be protected from extreme weather conditions and the roots shall be kept moist.

806-3.04 Planting:

(A) General:

On landscaping projects with irrigation systems, no planting shall be done until installation and acceptance of the irrigation system in total or

in increments. The initial watering and all subsequent watering of the planting shall be done using the newly constructed irrigation system. The plant material may need temporary irrigation systems acceptable to the Engineer for the initial watering of large plant material over and above the designed irrigation system.

(B) Nursery Stock:

After the planting pits are refilled with amended soil, and the irrigation system has been installed and accepted, the planting pits shall be pre-watered by the irrigation system for a minimum duration of twelve hours. Planting shall be accomplished during a three-day period starting two days following the prewetting as specified. Areas not planted during the three-day period shall be re-watered and allowed to dry as specified above.

Planting shall not be done in soil that is excessively moist or otherwise in a condition not satisfactory for planting in accordance with accepted horticultural practice.

Plants which are in containers, bare root, or balled and burlapped shall be planted and watered the same day the container, wrap, or moisture protection is cut.

The contractor shall adequately water plants to maintain a healthy and vigorous growing condition during the planting period.

Plants shall be removed from containers such that the root ball is not broken. Plants with broken root balls or with root balls that fall apart while being planted will be rejected.

Plants shall be planted plumb and shall be centered in the planting pit or trench. All planting pits shall have vertical sides and flat bottoms.

Backfill material shall be prepared soil conforming to the requirements of Subsection 806-2.05 of the specifications or prepared topsoil conforming to the requirements of Subsection 806-2.04 of the specifications. Backfill shall be carefully firmed around the roots or the ball of the plant so as to eliminate all air pockets and shall not be compacted around the roots or ball of the plants during or after planting operations.

Clods or stones exceeding 2 inches in diameter and foreign matter deemed objectionable by the Engineer will not be allowed. All excess soil that has objectionable stones shall be disposed of off the project site in a manner acceptable to the Engineer. No additional payment will be made for the removal and disposal of objectionable stone, or soil containing foreign matter.

Any excess soil which is not used to backfill the planting pits may be evenly distributed in the landscape areas if it will not interfere with the

final grading of any landscape areas. All planting areas shall be graded as specified to facilitate proper watering of all material, and leave a generally smooth appearance after completion of planting.

Plants shall be set to a depth such that, after backfilling and watering, the top of the root ball and the level of the backfill will match the surrounding grade as shown on the project plans. Any plant that settles more than 1-1/2 inches below the specified grade shall be reset or replaced. Any additional backfill material required shall be as specified in the Special Provisions and on the project plans.

Immediately after planting, all plants shall be thoroughly irrigated until the backfill soil around and below the roots or the root ball of each plant is saturated.

(C) Collected Stock and Local Stock:

If slings or cables are used to support stock during transporting and planting, the plant trunk shall be protected at the points of contact with slings and cables with burlap, canvas, sections of automobile tire casing, or other suitable protective material. Cables shall be placed to maintain proper support and balance at all times.

A tree spade may be used for digging and moving the stock. A thin layer of soil conditioner shall be placed in the planting hole before planting the stock with a tree spade.

Dead fronds, certain live fronds, flower stalks and seed pods shall be removed from palm trees, leaving a minimum crown of six to eight tiers of live fronds on each tree. Crown fronds shall be pulled together and loosely, but securely, tied in an upward position to protect the heart of the tree. Fronds shall be tied with light manila rope or multiple strands of binder twine. Frond ties shall remain in place for a minimum of 60 days after planting.

The contractor shall be responsible for preventing damage or death of the stock during moving operations and after planting is completed. Damaged stock shall be replaced with stock of the same species and of equal size.

After planting, the contractor shall maintain all collected stock and local stock in established positions during construction and landscaping establishment periods.

The contractor shall ensure that palms have been chemically sprayed with an approved preventative treatment to inhibit development of bud rot during the planting operation and during periods of high humidity and warm temperatures. The treatment shall be applied to allow deep penetration into the palm tree hearts.

Care shall be taken such that no palm tree is dropped or mishandled during the planting operations. Bending the palm tree trunk or causing uneven contact of the tree trunk with another surface may damage the palm tree heart and eventually kill the tree.

806-3.05 Pruning and Staking:

All plants shall be pruned in accordance with accepted horticultural practices. All dead and damaged twigs and branches shall be removed in order to form each type of plant to the standard shape for its species.

Trees shall be supported as shown on the project plans or as specified in the Special Provisions.

Tree-stakes shall be driven vertically at least 6 inches into firm, undisturbed ground at the bottom of the planting pit or trench. Stakes shall be positioned to clear the root system without disturbing the integrity of the roots.

Guying shall be as shown on the project plans or as directed by the Engineer.

Tree ties and guy wires shall be periodically inspected and adjusted as necessary to prevent "girdling" or injury to tree trunks or branches.

Trees shall be secured to the stakes with tree ties, after backfilling and prior to irrigating, as shown on the project plans and/or as specified in the Special Provisions.

806-3.06 Care and Protection of Trees, Shrubs and Plants:

Prior to beginning work under Section 807 of the specifications, the contractor shall be responsible for maintaining and protecting all planting areas, as specified in Subsection 807-3.02 of the specifications, including the care and protection of trees, shrubs and plants planted under this section. Such care and protection shall include, but not be limited to, the watering of stock; removal of construction trash and debris; eradicating and removing all weeds and undesirable vegetation as specified in the Special Provisions; repairing, adjusting or replacing stakes and guying; repairing weather damage or damage caused by the public; furnishing and applying sprays, dust and/or cages to combat vandalism, disease, insects and pests; and taking all precautions necessary to prevent damage from cold, frost, sunburn or other hazards. All existing undesirable grasses and weeds shall be eradicated with herbicides or manual methods during the construction phase, and disposed of by the contractor in accordance with Subsection 807-3.02 of the specifications.

The contractor shall remove and replace, at no additional cost to the Department, all dead plants and all plants that show signs of failure to grow or which are injured or damaged so as to render them unsuitable

for the purpose intended, as determined by the Engineer. The contractor may, with the approval of the Engineer, delay replacement of plants killed by frost until such time that frost is not imminent.

Plants shall be staked as detailed on the project plans. All wire ties used on plant staking shall be stapled to stakes in a manner acceptable to the Engineer. Staking shall be driven into undisturbed soil below the planting pit bottom as detailed on the project plans. Rubber hoses on tree ties shall be a minimum of 6 inches in length at each wire loop. All tie wire exposed to tree trunks shall be covered with hose or other material approved by the Engineer.

Any person or persons applying pesticides will be considered as doing so for hire and shall be licensed in accordance with the requirements of A.R.S. Title 3, Chapter 2, Article 6, Section 3-377.

The contractor shall notify the Engineer and obtain prior approval of the use of any chemicals for weed eradication or control. The types of herbicide to be used and the methods of application shall conform to Environmental Protection Agency requirements, the labeling instructions, and shall be as approved by the Engineer. The contractor shall keep a record of all applications, types of herbicide used such as pre- or post-emergent, rates and methods of application, and the dates and locations of such applications on forms supplied by the Engineer. A copy of this record shall be submitted to the Engineer after each application.

Pre-emergent herbicides or manual weed control shall be used on noxious weeds in planting areas located within the project limits; but noxious weed control within granite mulch, decomposed granite or rock mulch shall be as specified under those items of work. All areas shall be kept free of noxious weeds. All planting areas within the project limits shall receive an approved pre-emergent herbicide, as specified under Subsection 803-3.02 of the specifications. The application of herbicide shall include all areas not covered under other items of the specifications.

The contractor shall pay special attention to the infestation of nut and bermuda grasses. Either of these items found in the planting pits of that material shall be grounds for immediate removal, disposal, and replacement of that item. The planting pit shall be excavated and inspected to assure complete eradication of any roots or rhizomes which may have grown into the area. All this work and material shall be the responsibility of the contractor, at no additional cost to the Department.

806-4 Method of Measurement:

Planting trees, shrubs and plants, and transplanting trees, shrubs and plants will be measured on a lump sum basis, except that when the bidding schedule sets forth specific items under this section on a unit basis, measurement will be made by the unit for each item designated in the bidding schedule.

806-5 Basis of Payment:

The accepted quantities of trees, shrubs and plants, measured as provided above, will be paid for at the contract lump sum price or contract unit price each for the pay unit designated in the bidding schedule, complete in place.

No measurement or direct payment will be made for plants selected for inspection and not planted or for the care and protection of trees, shrubs and plants prior to the beginning of the Landscaping Establishment period, the costs being considered as included in the prices paid for plants accepted and paid for under the various contract bid items.

SECTION 807 LANDSCAPING ESTABLISHMENT:

807-1 Description:

The work under this section shall consist of the care of all stock in accordance with accepted horticultural practices; keeping all areas free of weeds, grasses and construction related debris; applying all irrigation water; repairing, adjusting or replacing stakes and guys; repairing public or weather damage; furnishing and applying sprays, dust and/or cages to combat vandalism, disease, insects and other pests; pruning as required by the Engineer; and the testing, adjusting, repairing and operating of irrigation systems; as shown on the project plans and in accordance with the requirements of these specifications.

807-2 Materials:

Materials necessary for the establishment of seeding and planted stock, and the operations of irrigation systems shall be furnished by the contractor and shall conform to the requirements of these specifications and the Special Provisions. The contractor shall notify the Engineer and obtain prior approval for the use of any chemicals for weed control or eradication.

807-3 Construction Requirements:

807-3.01 General:

The work period for landscaping establishment shall be the number of calendar days specified in the Special Provisions. The work period shall begin after all other work under the construction phase of the project has been completed and only when the Engineer is assured that the work can be performed in a continuous and consistent manner without restricting the use of any facilities by the traveling public.

Each month the contractor shall submit a work schedule of operations for approval by the Engineer. The work schedule shall show the dates

of work to be completed, including the dates of replanting, weed control, pruning, staking and guying, furnishing and applying sprays and dust to combat diseases, insects, and other pests, and irrigation testing or other work required by the Engineer.

Each calendar day during which the Engineer determines that no work under landscaping establishment is required, and the contractor is so advised, regardless of whether or not the contractor performs landscaping establishment work, will be used to reduce the total number of calendar days specified.

Each calendar day during which the Engineer determines that work under landscaping establishment is required, and the contractor is so advised, and the contractor fails to accomplish the required work, will not be used to reduce the total number of calendar days specified.

Thirty calendar days after the beginning of the landscaping establishment period and at the end of each additional 30 calendar days the Engineer, accompanied by the contractor, will inspect all landscaping items, planted stock and irrigation systems. The Engineer will notify the contractor at least one week in advance of the date for each inspection. The final inspection will be made approximately 21 calendar days prior to the expected termination of the landscaping establishment period.

A special inspection shall be performed at anytime during the landscaping establishment period when, in the opinion of the Engineer, conditions justify such action.

The contractor will not be required to keep planted areas cleared of trash and debris unless such trash and debris is a result of its operations. If, in the opinion of the Engineer, trash and debris has been deposited within the planted areas, not as a result of the contractor's operation, and such trash and debris is detrimental to the health and proper development of the plant material, the Engineer may require the contractor to clear the areas of this material. Payment for removal of trash and debris deposited within the planted areas, which is not a result of the contractor's operation, will be made in accordance with the requirements of Subsection 104.02 of the specifications.

The contractor's responsibility for the work during landscaping establishment shall be in accordance with the requirements of Subsection 104.10 of the specifications. All unacceptable planted stock, irrigation components and/or other work discussed at the monthly inspection and monthly irrigation testing shall be removed, replaced and/or repaired, as directed by the Engineer, at no additional cost to the Department within 21 calendar days from the date of the inspection. Payment for replacement of planted stock or irrigation components damaged by traffic or vandalism during landscaping establishment will be made in accordance with the requirements of Subsection 104.02 of the specifications. The contractor shall notify the Engineer in writing when the replacement work has been performed.

All erosion which occurs within decomposed granite, granite mulch and rock mulch areas shall be immediately repaired by the contractor to maintain the final grade in reasonably close conformity with the lines and grades shown on the project plans or as established by the Engineer. Erosion repair work shall be completed before the next monthly inspection and at no additional cost to the Department.

All electrical power required to maintain the landscaping will be supplied to the contractor at no charge during landscaping establishment. Electrical power used for electrical equipment and tools, and/or for the contractor's temporary offices shall be paid for by the contractor.

807-3.02 Planted Stock and Seeding Establishment:

All dead or unhealthy plant stock shall be removed and replaced, as directed, at no additional cost to the Department, within 48 hours from the date of the inspection and the contractor shall notify the Engineer in writing when the replacement work has been performed. Stock furnished for replacement shall be of the same size and species as originally specified. Unhealthy plant material may be corrected by the use of chemical and fertilizer applications where and when approved by the Engineer.

After the final inspection and when all dead or unhealthy stock has been removed and, if directed, replaced, the contractor will then no longer be responsible for the replacement of plant stock.

In case of certain plant stock found to be dead or unhealthy at the inspections specified above, the contractor may be ordered to remove certain dead or unhealthy plant stock and may be ordered not to replace such plant stock when nonreplacement would not adversely affect the planting design. The initial furnishing and planting, and the subsequent removal of such plant stock ordered removed and not replaced shall be at no additional cost to the Department.

All unpaved areas within the right-of-way shall be kept cleared of weeds and other undesirable vegetation unless otherwise specified in the Special Provisions.

The control of weeds shall be accomplished either with herbicides or by manual methods. The types of herbicides to be used and the methods of application shall conform to Environmental Protection Agency requirements and labeling instructions, and shall be as approved by the Engineer. The contractor shall keep a record of all applications; the type of herbicides used, such as pre- or post-emergent; the rate and method of applications; and the date and location of such applications. A copy of this record shall be submitted to the Engineer after each application.

All grasses or weeds shall be eradicated by spraying with a suitable herbicide and removing by manual means.

Any person or persons applying pesticides will be considered as doing so for hire and shall be required to be licensed in accordance with the requirements of A.R.S. Title 3, Chapter 2, Article 6, Section 3-377.

Lawn areas shall be mowed, weeded, edged and trimmed in accordance with standard horticultural procedures. Watering and fertilizing of lawns shall be done at intervals necessary to maintain a uniform, healthy, desirable green color and sturdy growth.

The contractor shall water and maintain seeded areas to provide a uniform and satisfactory stand of grass. To be acceptable, lawns shall have a good, uniform color and sturdy growth. At least 98 percent of the area designated to be planted shall have an acceptable lawn.

807-3.03 Irrigation System Establishment:

The irrigation system shall be tested, adjusted, repaired, and operated in the manner in which it was designed to function. Components such as backflow prevention units and pressure reducing valves as well as all other appurtenances shall function properly in accordance with the requirements of the design and the Special Provisions, together with the recommendations of the manufacturer. No change in the system as it was accepted under the contract shall be made without written approval of the Engineer.

During landscaping establishment, emission points of emitters shall be repositioned as directed by the Engineer. Additional tubes shall be installed where necessary, as directed by the Engineer. Staking of additional tubes shall be done in accordance with the details shown on the project plans.

The irrigation system shall be tested within one week prior to each scheduled inspection. Testing of the various components shall be as specified in the Special Provisions or as directed by the Engineer. The contractor shall keep a record of the results of all testing and shall submit a copy of these results to the Engineer upon completion of each test.

807-4 Method of Measurement:

Landscaping establishment will be measured on a lump sum basis or per month, as listed in the bidding schedule.

807-5 Basis of Payment:

The accepted quantity of landscaping establishment, measured as provided above, will be paid for at the contract lump sum price or at the contract unit price per month, which price shall be full compensation of the work, complete in place.

Payment will be based upon the length of the landscaping establishment period, as specified in the Special Provisions.

Partial payments may be made for landscaping establishment when the work is paid for at a contract lump sum price. Partial payment will be made only when the following work is completed prior to submittal of the monthly estimate:

(A) The Engineer's list of necessary work from the prior inspection; and

(B) The contractor's list of proposed operations from its monthly work schedule.

No measurement or payment will be made for the water, the cost being considered as included in the price of the contract item.

SECTION 808 WATER DISTRIBUTION:

808-1 Description:

The work under this section shall consist of furnishing all materials, equipment, tools and labor necessary to install a complete and functioning water distribution system and/or a complete and functioning landscape irrigation system in accordance with the details and at the locations shown on the project plans and the requirements of these specifications.

Water distribution plans are, in general, diagrammatic. The exact location of component units of the water distribution system will be specified by the Engineer.

The following water distribution terms, conditions, and component descriptions shall apply for installation of water distribution systems and/or landscape irrigation systems:

(A) Main lines and/or pressure mains are defined as the piping under constant pressure;

(B) Supply mains are defined as the piping from a water source to a water storage facility and may or may not be under constant pressure;

(C) Submains shall be the piping between a control valve (manual or automatic) and a pressure regulating device and not under constant pressure;

(D) Lateral piping is that on the discharge side of a control valve or pressure regulating device and not under constant pressure; and

(E) The work period for landscape establishment shall be the number of calendar days specified in the Special Provisions. Phasing of the project, when necessary, shall be as specified in the Special Provisions.

808-2 Materials:

808-2.01 Components:

(A) Backflow Prevention Unit:

Backflow prevention units shall be atmospheric, pressure or reduced pressure type and the size as specified. Backflow preventers and components shall conform to applicable codes, regulations, the project documents and the performance requirements of the Foundation for Cross Connection Control Research, University of Southern California. All testing of backflow prevention devices shall be as specified by the Foundation for Cross Connection Control Research, U.S.C.

Atmospheric and pressure type units may also be referred to as atmospheric vacuum breaker or pressure vacuum breaker.

(1) Atmospheric Backflow Preventer:

Atmospheric backflow preventers shall be all bronze body construction, non-spilling type with full size orifice, molded plastic or composition float disc. All units shall have female I.P.T. inlet and outlets sized as shown on the project plans and/or as specified in the Special Provisions.

Atmospheric units shall be rated to 125 pounds per square inch working pressure (minimum) and shall withstand water temperatures of 33 to 110 degrees F. The unit shall be installed with the air inlet in a level position.

(2) Pressure Backflow Preventer:

The pressure backflow preventer body and bonnet shall be bronze, and the air inlet hood or canopy shall be stainless steel or brass. Internally, the spring shall be stainless steel, the float shall be polyethylene and the vent and check discs shall be silicone rubber.

Internal components of the unit shall be serviceable without removal of the unit from the piping.

Pressure type units shall be rated to 150 pounds per square inch working pressure and shall withstand water temperatures of 33 to 210 degrees F.

Pressure backflow preventers shall incorporate one spring loaded check valve which will close tightly when flow through the unit drops to zero and shall have an air relief valve that opens to break siphon when the internal pressure drops to 1 pound per square inch.

Each backflow device shall be manufacturer equipped with bronze-bodied, resilient seat shut-off valves on the inlet and outlet of the device and two ball-type test cocks.

(3) Reduced Pressure Backflow Preventer:

The reduced pressure backflow preventer shall consist of two independently operating check valves, an independent relief valve, resilient seat inlet and outlet, full port ball type shut-off valves and test cocks. The unit shall be designed for installation in a normal horizontal flow attitude. The independent relief valve shall be located between the two check valves.

The backflow preventer shall include an integral sensing system that will automatically open the relief valve whenever the pressure upstream of the first check valve drops below 3 pounds per square inch greater than the pressure in the zone between the two check valves. The relief valve shall remain open until a positive pressure differential of 3 pounds per square inch is reestablished. The sensing passage shall be located within the unit housing to protect against accidental damage or crimping. To assure maximum size passageway, snubber or other restrictive elements shall not be used.

In the event that pressure upstream of the first check valve drops to atmosphere or below, the construction of the unit shall be such that during the normal operation of the device, the level of water in the zone between the two check valves shall be lowered to create within the unit an internal air gap which is greater than the diameter of the inlet pipe.

Both check valves and the relief valve shall be spring loaded poppet type of modular design such that the complete assembly including valve, spring and seat may be removed and replaced using low cost replacement kits.

All parts shall be made from corrosion resistant materials.

The design shall place the sensing diaphragm and passage within the unit housing to eliminate danger of malfunction due to mechanical or vandalism damage.

The backflow preventer shall conform to the following material, pressure and temperature range requirements:

Body	Bronze
Check Valve Enclosures	Glass Filled Noryl
Valve Disc	EPT Rubber
Diaphragm	Buna N and Nylon
"O" Rings	Buna N
Springs	Stainless Steel
Screws	Stainless Steel
Maximum Working Pressure	150 psi
Hydrostatic Test Pressure	300 psi
Temperature Range	33 °F – 210 °F

Construction of the backflow prevention unit shall be such that any minor leakage at the second check valve will result in a visible flow from the relief valve even if the first check valve is totally disabled.

Each reduced pressure backflow preventer shall be factory assembled and tested prior to delivery.

(B) Gate Valve:

Gate valves shall be the type and size specified on the project plans or in the Special Provisions. Identification of the valve by trade name, manufacturer and/or model number shall be stamped or cast on the valve body or on a permanently attached metal plate or tag. Unless otherwise specified, valves installed above ground shall be equipped with handwheels. Valves installed below grade shall be equipped with an operating nut or a cross handle, except a gate valve installed adjacent to a remote control valve, which shall be equipped with a handwheel.

A minimum of one operating key or wrench shall be provided for each size operating nut or cross handle.

(1) Gate Valve (3 Inches or Smaller):

Gate valves 3 inches or smaller shall be Class 125, bronze body, nonrising stem type with solid disc, screwed bonnet and required operator.

The bronze components of the valve shall conform to the requirements of ASTM B62 with the exception of the stem which shall conform to ASTM B371, Alloy 694. The handwheel, where required, shall be non-corrosive metal.

Valve end connections shall be as specified in the Special Provisions or as detailed on the project plans.

(2) Gate Valve (4 Inches or Larger):

Gate valves 4 inches or larger in size shall be iron body, bronze mounted and shall conform to the requirements of Federal Specification WW-V-

58 Class 1, Type 1, for Class 125 valves having non-rising stem, bolted bonnet and solid wedge configuration.

End connections and required operator shall be as detailed on the project plans and/or as specified by the Federal Specifications.

(C) Quick Coupling Valve:

The quick coupling valve shall be bronze or brass with a 3/4-inch iron pipe size (I.P.S.) female inlet connection unless otherwise specified or detailed. The valve body shall be of two-piece construction with single slot and spring loaded self-closing valve with metal or rubber cover. All 3/4-inch quick coupling valves shall have a flow range of 10 to 20 gallons per minute and an operating pressure range of 5 to 125 pounds per square inch. All quick coupling valves shall be of a single manufacturer.

Two quick coupling keys appropriate to the valve shall be provided for each 10 valves installed.

Quick couplers shall be installed on an approved swing joint riser assembly consisting of two PVC male adapters with Acme threads and elastomer seals, one polyvinyl chloride (PVC) 90-degree street elbow with male and female Acme threads and two PVC 90-degree elbows with socket by female Acme threads. Necessary pipe, fittings and/or nipples shall be PVC Schedule 80; with the length as required.

Swing joint assembly shall be capable of withstanding a working pressure of 200 pounds per square inch at 73 degrees F.

(D) Remote Control Valve:

The remote control valves shall be the types and sizes specified. The manufacturer's name and identification shall be cast molded or stamped on the valve body or on a permanently attached metal plate or tag. Valves shall have a minimum service rating of 150 pounds per square inch. Valve bodies, bonnets and component parts shall be as specified herein or in the Special Provisions.

All valves shall have accurately machined or molded valve seat surfaces and internal parts. End connections shall be machined or molded female I.P.S. thread unless otherwise specified. Electrically operated valves shall be fully compatible and fully functional in all modes with the automatic controller device specified for the project.

(1) Remote Control Valve (Plastic):

The plastic remote control valve shall be a normally closed, 24-volt A.C., 50/60-cycle, solenoid-actuated globe pattern, diaphragm-type valve capable of regulating water flow for the specified system operation. Valve pressure rating shall not be less than 200 pounds per square inch.

The valve body and bonnet shall be constructed of glass filled nylon with the handle, rings and diaphragm hardware of Acetal. Diaphragm shall be constructed of nylon reinforced Nitrile rubber. "O" rings shall be Ethylene Propylene rubber. Valve stem shall be brass and all studs and flange nuts shall be stainless steel.

The valve shall be actuated by a low power, epoxy encapsulated 24-volt A.C., 50/60-cycle solenoid with an in-rush power requirement of 0.41 amperes (9.9 VA) and a holding current of 0.23 amperes (5.5 VA). Control water pressure for the solenoid actuator shall be delivered from the inlet of the valve to the actuator by means of an internal or external passage particular to the valve size.

Each valve shall be equipped with a manual on-off control and flow adjustment control. Manual operation of the valve shall be by manual internal or external bleed.

The valve construction shall be such as to provide for all internal parts to be removable from the top of the valve without disturbing the valve installation.

(2) Remote Control Valve (Brass):

The brass bodied remote control valve shall be a normally closed, 24-volt A.C., 50/60-cycle, solenoid-actuated globe pattern, diaphragm-type valve capable of regulating water flow for the specified system operation.

The valve body and bonnet shall be constructed of heavy cast brass. The diaphragm shall be nylon reinforced nitrile rubber. The valve stem and cross handle shall be brass and all studs shall be stainless steel. The internal seat spring shall be stainless steel.

The valve shall be actuated by a low power, epoxy encapsulated 24-volt A.C., 50/60-cycle solenoid with an in-rush power requirement of 0.41 ampere (9.9 VA) and a holding current of 0.23 ampere (5.5 VA). Control water pressure for the solenoid actuator shall be delivered from the inlet of the valve to the actuator by means of an internal or external passage particular to the valve size.

Each valve shall be equipped with a manual on-off control and flow adjustment control. Manual operation of the valve shall be by manual external bleed.

The valve construction shall be such as to provide for all internal parts to be removable from the top of the valve without disturbing the valve installation.

(E) Automatic Controller:

The automatic controller shall be electro-mechanical, electro-mechanical semi solid-state or microprocessor based / micro electronic solid-state type, and capable of fully automatic or manual operation of the irrigation system. The controller shall be housed in a wall or in a steel or metal cabinet which is lockable, pedestal mountable and waterproof. The type or types of auto controllers shall be as detailed on the project plans or as specified in the Special Provisions.

The controller shall operate on a minimum of 117 volts A.C. power input and shall be capable of operating 24-volt A.C. electric remote control valves.

(F) 24-Volt Wire (Ground and Control):

The 24-volt control and ground wire for operation of remote control valves shall be AWG size, UL approved, 600-volt, type UF single conductor wire with 60-mil PVC insulation. All control ("hot") wiring shall be a contrasting color to the white common or ground wire. Black wire will not be acceptable for use on any 24-volt control circuit. Control wires to water distribution valves used for shrubs shall be a different color than those used for trees. Wire color shall be approved by the Engineer.

Control and ground wire sizes shall be the sizes indicated on the project plans. Individual control wires shall be installed to each remote control valve. Common wire installation shall be as detailed on the irrigation system master plan.

(G) Pressure Gauge:

The pressure gauge, portable or permanently mounted, shall be suitable for use with water and have a 2-inch diameter case with hermetically sealed neoprene cover, molded-in diaphragm and a shatterproof crystal. Pressure gauges shall have a range of zero to 60 pounds per square inch, unless otherwise specified.

Portable pressure gauges shall be equipped with rubber hose and "tire chucks" capable of attachment to Schrader valves located at various pressure-check locations throughout the project for purposes of verifying pressures and making adjustments as necessary.

Permanently mounted pressure gauges shall be equipped with external or internal pulsation dampeners. All permanently mounted gauges shall be equipped with resilient seat, shut-off valves.

(H) Insulation:

The insulation shall be 1-inch thick, all-service jacket, heavy density glass fiber, sectional pipe insulation with vinyl coated, embossed, vapor

barrier laminate. The jacket shall have a pressure sensitive, self-sealing lap. All insulation shall receive an exterior protective cover of 0.016-inch aluminum secured with 3/8-inch aluminum straps located 6 inches center to center.

(I) Pipe:

(1) Polyvinyl Chloride (PVC):

Plastic pipe and fittings shall conform to the requirements of the National Sanitation Foundation and bear their stamp.

Materials used in the manufacture of PVC pipe and fittings shall conform to the requirements of ASTM D1784, Class 12454-B.

PVC pipe shall conform to the requirements of ASTM D2241 for SDR-PR pipe and ASTM D1785 for Schedule 40 and Schedule 80 pipe.

The pipe classification and the pressure rating will be specified on the project plans or in the Special Provisions.

PVC pipe, unless otherwise specified, shall be plain-end solvent weld or bell-end solvent weld. Bell-end solvent weld pipe shall conform to the requirements of ASTM D2672.

PVC piping shall be assembled with solvent weld, socket type fittings.

All PVC fittings shall conform to one or more of the following requirements:

(a) ASTM D2466 for Schedule 40 socket type fittings; and/or

(b) ASTM D2467 for Schedule 80 socket type fittings.

(2) Steel:

Galvanized and black steel pipe shall conform to the requirements of ASTM A53.

All threaded steel pipe fittings shall be heavy pattern, banded, malleable iron with a rating of 150 pounds per square inch working pressure. Fittings shall be galvanized or black steel appropriate to the piping being used. Flanges or flanged fittings, where specified, detailed or required, shall be Standard, Class 125 or Extra Heavy, Class 250 conforming to ANSI B 16.1.

The type of pipe and fittings which shall be used will be specified on the project plans or in the Special Provisions.

(3) Copper

All copper pipe shall be rigid or non-rigid copper, Type K Standard, meeting the requirements of Federal Specification WW-T 799 and ASTM B88. Fittings shall be standard copper, wrought and cast. Solder shall be of the lead free type.

808-2.02 Water Distribution System:

Water distribution systems which include unique or variable components not listed in Subsection 808-2.01 of the specifications shall conform to the component requirements specified in the Special Provisions.

808-2.03 Landscape Irrigation System:

Landscape irrigation systems which include unique or variable components not listed in Subsection 808-2.01 of the specifications shall conform to the requirements specified in the Special Provisions.

808-3 Construction Requirements:

808-3.01 Materials and Equipment:

By the time of the preconstruction conference, the contractor shall submit the manufacturer's product sheets of the materials and equipment it proposes to use to the Engineer electronically. In addition to the electronic submission, the Engineer may request up to three hard copies. The contractor shall have materials and equipment correctly marked on each copy of the manufacturer's product sheets. These product sheets shall also show the catalog numbers, manufacturer's name, model numbers, sizes, capacity, complete specifications, instructions, design data and/or drawings, to determine whether or not each piece of material or equipment is acceptable and to assure that all such materials and equipment, when incorporated into the work, is in accordance with the project plans and the specifications. The contractor's failure to comply with these material submittal instructions will not constitute a time extension.

No material or equipment shall be ordered and work shall not begin until the material and equipment has been approved, in writing, by the Engineer.

All water distribution system equipment shall be installed in accordance with the instructions of the manufacturer, the project plans, and specifications. The contractor shall provide the Engineer each manufacturer's installation instructions electronically. In addition to the electronic submission, the Engineer may request up to three hard copies.

All irrigation construction materials for single use on the projects shall be supplied from a single manufacturer, unless otherwise specified in the Special Provisions.

808-3.02 Permits, Warranties, and Guaranties:

Any warranty, guaranty, operation and/or maintenance manuals provided by the manufacturer for any item shall be furnished to the Engineer prior to final acceptance of the project or prior to the landscape establishment phase, when the project includes landscape establishment phase or upon request by the Engineer.

All permits for installation or construction of any of the work included under Section 808 of the specifications, which are required by legally constituted authorities having jurisdiction, shall be obtained and paid for by the contractor, each at the proper time. The contractor shall also arrange for and pay all costs in connection with any inspections and examinations required by these authorities.

No measurement or direct payment will be made for any permits, the cost being considered as included in the price of the contract items.

808-3.03 General Requirements:

Any use of potable water by the contractor shall be through approved backflow prevention devices. All backflow prevention devices shall be in place, tested and approved for use by the Engineer prior to the contractor using any water from the municipal water system.

Prior to beginning trench excavation, the contractor shall lay out the system or systems for the approval of the Engineer by providing approved indicators at the location(s) of major components such as piping runs, valves, pumps, backflow preventers and tanks. Under no circumstances shall shut-off valves of any type be installed downstream from any atmospheric type backflow prevention device. With the exception of reduced pressure type, backflow preventers shall not be subject to back pressure. Structures and enclosures shall be indicated as directed by the Engineer.

The contractor shall locate any existing water distribution system piping and appurtenances within the limits of the project which will be affected by new system construction and/or revisions.

Utility connections, both water and electrical, shall be as shown on the project plans or as determined by the utility company. Unless specifically exempted in the plans or specifications, the contractor shall be responsible for all costs to provide these services.

The contractor shall assume full responsibility for the correct installation of the water distribution system, as herein specified, and unless it can show past experience of installing this type of system, it shall arrange

with the manufacturer for the services of a qualified manufacturer's representative to be on hand at the start of the installation and as necessary during the installation and testing of the system.

All materials and fittings shall be new, of manufacturer's most current design, and shall bear the appropriate national association's seal of approval; for example, NSF and UL. Similar parts shall be procured from the same manufacturer, and internal parts shall be common and interchangeable. Parts listing and source of supply for replacement parts shall be furnished to the Engineer. The contractor shall provide two complete manuals of all materials, equipment, parts, and manufacturer's installation, maintenance and owner manuals, to the Engineer prior to final project acceptance.

All enclosures shall remain closed and locked, and all valve box covers shall be in place throughout the construction and landscaping establishment periods, except when actual work is in progress on the respective unit.

The contractor shall furnish sufficient numbers of pressure gauges with tire chucks, which shall be used in the testing and necessary adjustment of the emitter system during construction and landscaping establishment.

All pressure regulators shall be tested at 90-day intervals throughout the construction phase and landscape establishment phase of the contract. Regular tests shall be performed a minimum of three working days prior to regularly scheduled project inspections.

Plastic pipe shall be delivered to the site in unbroken bundles or packages and shall be wrapped such that pipe ends are adequately protected. If the pipe is delivered from a local warehouse, the pipe need not be bundled or wrapped.

Upon delivery to the site, the contractor shall inspect all pipe for possible shipping damage. Shipping straps shall be removed to prevent damage due to expansion in hot weather.

All copper pipe required to install the backflow prevention unit or fertilizer injector assembly shall be type "K," hard drawn, of the size shown on the project plans. Copper fittings shall be wrought or cast, and of the configuration and size shown on the project plans.

All PVC pipe and fittings shall be stored as recommended by the manufacturer and as directed by the Engineer. All PVC pipe shall be covered to prevent exposure to sunlight. Sufficient air space shall be provided between the opaque covering material and the pipe to prevent undue heat buildup and retention.

PVC pipe which has been discolored by exposure to sunlight or has been scratched, scored or otherwise damaged in handling will not be acceptable.

Plastic pipe and fittings shall be installed in accordance with the requirements specified herein and the manufacturer's recommendations.

Any PVC fitting or nipple marks from any device other than a strap tightening wrench shall be removed and replaced with a new component. Any system replaced shall be retested as herein specified.

No water distribution system main piping, laterals, other piping, or other components shall be installed through or beneath new or existing plant pits or plant material. The minimum distance between the plant pit and piping shall be 12 inches. Maximum distance between the plant pit and piping shall be determined by maximum supply lengths as specified on the project plans.

Additional flushing of the irrigation system, in addition to those specified, may be required by the Engineer to assure proper function of the system, including emission points.

Testing of the irrigation system valves shall be performed at system operating pressure or 60 pounds per square inch, whichever is greater.

Trenches shall be excavated to uniform grade and shall be no wider than is necessary for the proper installation of the pipe, fittings and control wiring. The bottom of the trench shall be firm and free from large or sharp rocks.

Where pavement or other impervious material is encountered in the excavation of trenches, such material shall be removed and wasted, as approved by the Engineer. No separate payment will be made for removal and disposal.

All pipe, fittings and system components shall be clean prior to installation and shall be maintained in that condition during installation.

Plastic pipe shall be uniformly bedded and covered to the depth indicated on the project plans. Bedding and backfill material shall be compacted by approved water settlement methods and, after backfilling has been completed, the surface shall be brought to the elevation of the adjacent ground. The contractor shall select a 100-foot section of mainline which has been installed and backfilled as a test portion to be water settled for the Engineer's approval of the water settlement method. The test shall be completed and approved prior to proceeding with the remainder of the project.

Requirements for slack or "snaking" of PVC pipe shall be in accordance with the pipe manufacturer's recommendation. PVC pipe and fittings

shall be clean prior to installation and shall be maintained in that condition during installation.

Where two or more piping systems are indicated on the project plans as adjacent, they shall be placed within a common trench and at the depths indicated.

Where threaded plastic to metal or plastic to plastic connections are required, the metal connections shall be worked first. A non-hardening, manufacturer recommended sealant/lubricant compatible with the plastic fittings and/or components shall be used and the joint shall be hand tightened with the final tightening not to exceed one turn with a strap wrench.

Threaded PVC Schedule 80 nipples, thread-one-end (T.O.E.) and PVC Schedule 80 couplings, solvent weld, shall be used where threaded plastic connectors are required. Threaded PVC male or female adapters are not acceptable, unless otherwise specified.

Cement, solvents, thinners and joint compounds shall be compatible with and of the kind recognized by the industry as proper for use with the plastic pipe and fittings involved. Solvent weld pipe and fittings shall be assembled using appropriate primers and solvents designated by the manufacturer for use with Schedule 40 and/or Schedule 80 fittings.

All wire connections for No. 10 or larger shall be wrapped in accordance with the requirements of Subsection 732-3.02(B) of the specifications.

All control valve boxes and pressure regulator boxes shall be labeled with a brass tag acceptable to the Engineer.

All wire shall be tagged in accordance with the requirements of Subsection 732-3.02(C) of the specifications. Flexible conduit shall be supported within 12 inches of any cabinet or fitting in accordance with the requirements of NEC 350 and in a workmanlike manner acceptable to the Engineer.

All surfaces or components requiring protective paint shall receive the finish as specified in Sections 610 and 1002 of the specifications, and as determined by the Engineer.

The contractor shall furnish and install a steel post to mark the ADOT end caps, in accordance with Standard Drawing 4-M-4.01, to a height of 30 inches without the reflector.

At no time shall any plant material, new or existing, be allowed to remain without water for any period which will result in stress to the plant material. Any damage to plant material because of lack of water shall be rectified at no additional cost to the Department.

Water distribution and/or irrigation systems shall be installed, tested, operational and approved by the Engineer prior to installation of any new plant material.

Flush end caps shall be installed as shown on the project plans or as directed by the Engineer to promote good flushing of the entire irrigation system. Additional flushing of the irrigation system, in addition to those specified, may be required by the Engineer to assure proper function of the system including emission points.

808-3.04 Bedding and Cover Material:

Bedding and cover material for PVC piping, flexible emitter hose and 24-volt wiring shall conform to the following gradation requirements when tested in accordance with AASHTO T 11 and AASHTO T 27:

Sieve Size	Percent Passing
No. 4	100
No. 16	30 - 80
No. 50	0 - 30
No. 100	0 - 25
No. 200	0 - 20.0

All piping and 24-volt wire shall be installed as detailed on the project plans and shall have the minimum cover shown.

Gravel sumps, as detailed on the project plans, shall be crushed coarse aggregate Number 57 conforming to the requirements of AASHTO M 43.

808-3.05 Components:

Components shall be as required by the details shown on the plans, in the project Special Provisions, as specified herein, and as directed by the Engineer.

(A) Backflow Prevention Unit:

The backflow prevention unit shall be installed with necessary supports as required by the project documents. The piping, as detailed shall not be considered as adequate support. Shop drawings shall be provided by the contractor in accordance with the requirements of Subsection 105.03 of the specifications. The supports shall receive protective paint finish as specified in Sections 610 and 1002 of the specifications. Final finish shall be as specified by the Engineer.

All exposed piping and unit bodies used in conjunction with the backflow preventer and the backflow preventer shall receive a protective covering of insulation as specified.

Access to all drains, vents, operators, unions or reliefs shall be maintained and the insulation shall not restrict their operation.

The backflow prevention units shall be tested in accordance with the requirements as specified in the Manual of Cross-Connection Control Recommended Practice, as published by the Foundation for Cross-Connection Control Research, University of Southern California.

Testing of backflow prevention unit shall be performed by the authorized service-test personnel. Test reports shall be recorded on forms provided by the Engineer. No separate payment will be made for testing.

Testing of backflow prevention units by authorized service-test personnel shall be performed before acceptance of both the construction phase and landscape establishment phase. In addition, testing shall be performed following any repairs or servicing of units.

All backflow prevention devices shall be in place, tested and approved for use by the Engineer prior to the contractor using water from any potable water system.

All testing shall be with available water pressure from the approved points-of-connection (P.O.C.), unless otherwise directed by the Engineer. Bench testing remote from the designated location of the unit will be unacceptable.

(B) Gate Valve:

Gate valves shall be the size(s) as indicated in the project documents. Gate valve size shall be equal to the larger adjacent pipe size as indicated on the project plans.

All gate valves installed beyond structure lines shall be installed within specified valve boxes. No valves shall be placed beneath structures, sidewalks, roadway surfaces or within structural walls or columns unless shown on project plans and approved by the Engineer.

Concrete support blocks for mainline gate valves shall be the type and size indicated on the project plans. Support blocks shall be installed under the gate valve body and shall not contact or support the adjacent pipe and fittings. Support blocks shall be placed on undisturbed soil or soil which has been compacted as specified in Subsection 203-5.03(B)(4) of the specifications. No separate payment will be made for the support block.

Gate valves installed in valve boxes or enclosures below grade shall be exposed in entirety within the valve box. Extensions shall be added to valve boxes as necessary to prevent the surrounding soil or gravel sump from encroaching on the valve body and associated piping or fittings.

(C) Quick Coupling Valve:

Quick coupling valves, the type and size as detailed on the project plans and as specified, shall be installed on the approved swing joint riser assembly. Additional pipe and/or nipples required to complete the swing joint assembly shall be PVC, Schedule 80; length shall be as required.

Quick coupling valves shall be anchored to prevent movement as detailed on the project plans.

(D) Remote Control Valve:

Remote control valves shall be installed as detailed on the project plans. Size of valves shall be as shown on the plans or as specified in other project documents.

Unless otherwise detailed or specified, all remote control valves for use on irrigation systems shall be preceded by a gate valve. The gate valve shall be the size detailed or sized to the larger of either the control valve or the adjacent pipe.

Remote control valves, accompanying gate valves and other required appurtenances shall be completely exposed and accessible within the valve box. Valve box extension shall be added as necessary to provide valve access and inspection/maintenance.

(E) Automatic Controller:

Automatic controllers (or field satellite) shall be installed as detailed and specified in the project documents, as recommended by the manufacturer and as approved by the Engineer.

Controller enclosures shall remain closed and locked throughout the project duration except when actual work is in progress on the respective unit.

Any finish or enclosure component damaged during transport or installation shall be repaired or replaced as directed by the manufacturer and approved by the Engineer.

Remote control valve wire (ground and control) shall terminate within the automatic controller cabinet at a manufacturer supplied terminal strip. All connections shall be labeled as to function and/or valve number as approved by the Engineer. Incoming electrical supply circuit(s) shall be separated from the low voltage (24-volt) circuits by approved conduits or separator panels as approved by NEC and prevailing local codes.

(F) Control and Ground Wire (24-Volt):

Remote control wire (24-volt) shall be installed as specified by the project documents and Standard Specifications.

Control wires to be installed throughout pipe sleeves shall be encased in PVC electrical conduit of appropriate size to contain the required number of conductors as determined by standard conduit sizing tables. Conduits shall extend 1 foot beyond each end of the sleeve unless otherwise noted.

Wire connections at remote control valves and at field splices shall be made with specified wire connectors installed as recommended by the manufacturer. No field splices of 24-volt wiring shall be made unless the length between connections or splices exceeds 2,500 feet. Necessary splices shall be made at remote control valve boxes or separate splice boxes.

Control and ground wire throughout the project shall be neatly bundled and taped with plastic electrical tape at 10-foot intervals between splices and/or connections and as directed by the Engineer.

(G) Emitters:

The number of emitters per riser circuit, as shown on the project plans, is approximate. The contractor shall add no more than five additional single outlet emitters or one multi-outlet emitter per circuit, as detailed. Any additional emitters required and exceeding the above indicated amount must be approved by the Department.

The contractor shall assume full responsibility for the correct installation of the emitter system, as herein specified, and unless it can show past experience of installing this type of system, it shall arrange with the manufacturer for the services of a qualified manufacturer's representative to be on hand at the start of the installation and as necessary during the installation and testing of the system.

The contractor shall use the appropriate installation tools as recommended by the respective manufacturers for correct installation of emitters and emitter tubing.

(H) Insulation:

All exposed pipe, fittings and unit bodies used in conjunction with the backflow preventers, fertilizer injectors and filter units as well as all exposed piping and valves at the water storage facilities and pumping facilities shall receive a protective covering of insulation. Access to all drains, vents, operators, unions or relief’s shall be maintained and shall not be restricted in their operation by the insulation.

Insulation shall be installed in a workmanlike manner with no voids or openings which will deter from the effectiveness of the insulation.

The contractor shall assume full responsibility for the correct installation of the insulation and shall arrange with the manufacturer for the services of a qualified manufacturer's representative to be on hand at the start of the insulation installation and as necessary during installation to assure proper application of all insulation materials.

808-3.06 Testing Prior to Backfilling:

The contractor shall furnish a sufficient number of pressure gauges with "tire chucks" which shall be utilized in the testing and necessary adjustment of the water distribution system during construction and landscaping establishment.

At the completion of the landscaping establishment period, the contractor shall deliver two pressure gauges and two tire chucks to the Engineer.

All enclosures shall remain closed and locked and all valve box covers shall be in place throughout the construction and landscaping establishment periods except when actual work is in progress on the respective unit.

When tests have been completed and any necessary repairs have been completed and accepted, trenches shall be backfilled. Pipe lines shall be normalized by water cooling the system just prior to beginning backfilling operations.

The irrigation laterals shall be thoroughly flushed following assembly and backfilling of the trench. All laterals shall receive an additional flushing prior to installation of the irrigation heads. Additional flushing of the water distribution system may be required by the Engineer to assure proper function of the system including irrigation system devices.

The contractor shall operate the irrigation system automatically for a minimum of five days prior to final acceptance of the construction phase and for the duration of landscape establishment phase. The contractor may operate the system manually, in addition to the automatic mode and as necessary during landscape establishment phase, as approved and directed by the Engineer.

Any mechanical failure or leak that occurs during the establishment period shall be repaired or the defective materials shall be removed and replaced as directed by the Engineer. The system shall be retested as herein specified.

808-3.07 Water Distribution System:

The specifications for installing a water distribution system will be provided in the Special Provisions.

808-3.08 Landscape Irrigation System:

The specifications for installing a landscape irrigation system will be provided in the Special Provisions.

808-3.09 Water Distribution System Testing:

Following completion of the installation of mains, control valves, gate valves and other components, and after all solvent-welded joints have cured for 24 hours, the water distribution system and/or landscape irrigation system shall be tested in accordance with the requirements of the Specifications and as approved by the Engineer.

Under no circumstances will air pressure be acceptable for testing.

The contractor shall flush and bleed all lines prior to testing. Metal or plastic caps shall be used to facilitate flushing and testing. Backfill material placed on the lines shall be limited to the quantity required to stabilize the lines under pressure and to serve as insulation during testing procedures. During testing, all fittings and couplings shall be visible for inspection. Any failures evident during the test shall be repaired and the system retested before backfilling. The contractor shall furnish the necessary equipment required to perform the piping tests. No additional payment will be made for materials required to perform tests.

Any mechanical failures or leaks which develop during testing shall be repaired or the defective materials shall be removed and replaced. After replacements or repairs have been made, the entire testing procedures shall be repeated until it is determined that there are no leaks or failures in the irrigation system.

Unless otherwise specified in the Special Provisions, the pressure mains and sub-mains shall be subjected to a static pressure test of 100 pounds per square inch gage for a minimum period of two hours. During this time all solvent-welded and threaded connections and component parts shall be inspected to determine that no leaks exist.

After installation of emitter laterals and supply tubing, but before installation of emitters, the emitter laterals and supply tubing shall be subjected to one hour of pressure testing, (pounds per square inch gage) at maximum lateral operating pressure unless otherwise directed by the Engineer, during which time components shall be inspected for leakage.

All valves shall be tested in sequence, starting at the valve most remote from the source of water supply, to subject the mainlines to surge

pressure. All valves shall be operated manually. All electric remote control valves shall also be tested electrically and meet the satisfaction of the Engineer prior to burial of wiring.

In addition to the aforementioned testing, the contractor shall perform the various testing procedures listed under the various individual bid items. These tests shall be performed in the presence of the Engineer. The results of the tests shall be documented and provided to the Engineer at the completion of the testing procedure. Test document forms shall be provided by and/or approved by the Engineer.

808-4 Method of Measurement:

Water distribution systems or landscape irrigation systems will be measured either by the system for each system installed or by the unit each for each component furnished and installed, which collectively comprises the system. The applicable unit of measurement will be as designated in the bidding schedule.

808-5 Basis of Payment:

The accepted quantities of water distribution system or landscape irrigation system, measured as provided above, will be paid for at the contract unit price for the pay unit designated in the bidding schedule, which price shall be full compensation for the item, complete in place, including excavation and furnishing all labor and materials necessary to provide a functioning water distribution system or landscape irrigation system.

SECTION 809 SEWERAGE SYSTEM:

809-1 Description:

The work under this section shall consist of furnishing and constructing a complete and functioning sewerage system, including all appurtenances, excavating, backfilling, setting of all parts of the system to the indicated lines and grades, testing the system and the disposal of excess materials, all in accordance with the details and at the locations shown on the project plans and the requirements of these specifications.

809-2 Materials:

809-2.01 Plastic Sewer Pipe:

The contractor may, at its option, use either acrylonitrile-butadiene styrene (ABS) or polyvinyl chloride (PVC) sewer pipe. All plastic sewer pipe shall be SDR 35 in the sizes indicated on the project plans.

ABS pipe and fittings shall be manufactured in accordance with the requirements of ASTM D2751. Solvent cement conforming to the requirements of ASTM D2235, shall be used on all ABS plastic pipe joints.

PVC pipe and fittings shall be manufactured in accordance with the requirements of ASTM D3034. Solvent cement conforming to the requirements of ASTM D2564 or elastomeric rubber ring gasket joints conforming to the requirements of ASTM D3212, shall be used on all PVC plastic pipe joints. All pipe joined with rubber ring gasket joints shall be the push-on, bell and spigot type. Each bell joint shall consist of an integral factory made formed bell complete with a single rubber gasket.

809-2.02 Iron Pipe and Fittings:

All iron pipe shall be ductile iron pipe conforming to AWWA Standard C-151. All fittings shall be either cast iron or ductile iron pipe fittings conforming to AWWA Standard C-110. All iron pipe shall be of the sizes and classes shown on the project plans.

All iron pipe and fittings shall have an inside cement-mortar lining conforming to AWWA Standard C-104.

809-2.03 Filter Fabric:

Filter fabric shall conform to the requirements of Subsection 1014-4 of the specifications for the fabric survivability rating shown on the project plans or specified in the Special Provisions.

809-3 Construction Requirements:

809-3.01 General:

By the time of the preconstruction conference, the contractor shall submit a complete list of all materials and equipment that it proposes to incorporate into the work and the manufacturer’s product sheets for each item on the list to the Engineer electronically. In addition to the electronic submission, the Engineer may request up to three hard copies. The contractor shall have materials and equipment correctly marked on the list and manufacturer's product sheets. The list and product sheets shall also show the catalog numbers, manufacturer's name, model numbers, sizes, capacity, complete specification, instructions, design data and/or drawings, to determine whether or not each piece of material or equipment is acceptable and to assure that all such materials and equipment, when incorporated into the work, is in accordance with the project plans and specifications. The contractor's failure to comply with these material submittal instructions will not constitute a time extension.

No material or equipment shall be ordered and work shall not begin until the material and equipment has been approved, in writing, by the Engineer.

Construction of sewerage systems shall be governed by the applicable requirements of the ADEQ.

All plastic and iron pipe shall be transported, handled and stored in accordance with the manufacturer's recommendations. PVC plastic pipe shall be protected from sunlight with an opaque covering.

Workmen and inspectors shall be protected from the collapse of trench walls during the excavating for and the placing of pipe and septic tanks, during the placing and compacting of all bedding and backfill material and during the determination of all earth work densities.

809-3.02 Manholes:

Manholes and covers shall be constructed in accordance with the requirements of Section 505 of the specifications and as shown on the project plans.

809-3.03 Septic Tanks:

Septic tanks shall be constructed in accordance with the project plans and the current guidance from the ADEQ.

Septic tanks shall be water tight and constructed with Class S concrete which has a 28-day compressive strength of at least 3,000 pounds per square inch and Grade 40 or better steel reinforcing bars. If precast septic tanks are used, a bituminous or mastic gasket shall be used to seal the joints between each precast section.

The liquid depth in the septic tank shall not be less than 4 feet or greater than 6 feet. The inside length of the septic tank shall be between two and three times the inside width. The inlet and outlet of the septic tank shall consist of pipe tees which shall be sized to match the sewer line.

The septic tank shall have three access openings in the tank top. One opening each shall be located over the tank inlet and outlet and the third opening shall be located in the middle of the tank. Concrete adjustment rings shall be used as required so that all three access openings are within 6 inches of the finished grade.

Backfill around and over the septic tank shall be placed in lifts not greater than 12 inches and thoroughly compacted in a manner that will not place undue strain on the septic tank.

809-3.04 Plastic Sewer Pipe:

The installation of solid wall plastic sewer pipe shall conform to the requirements of ASTM D2321.

Trenches for plastic sewer pipe shall be excavated to a uniform grade which will not cause undue deflection of the pipe. The width of the trench at any point below the top of the pipe shall not be greater than that necessary to provide adequate room for joining the pipe and compacting the haunching and initial backfill. The trench bottom shall be firm and free of large or sharp rocks.

Materials for the pipe bedding, haunching and initial backfill shall conform to the requirements of Subsection 808-3.04 of the specifications.

Materials for pipe bedding, haunching and initial backfill shall be placed in lifts of not more than 8 inches in depth before compaction, and each lift shall be compacted to at least 90 percent of maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

If rock is encountered during trench excavation, all rock shall be removed to provide a clearance of at least 6 inches below and on each side of the pipe and fittings. After excavation of all rock, 6 inches of pipe bedding material shall be placed in the bottom of the trench and compacted to at least 95 percent of maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Other pipe bedding shall be a minimum of 4 inches in depth under the pipe and shall be installed to ensure adequate support of the pipe barrel throughout its entire length. The haunching shall be placed completely around the pipe up to the spring line of the pipe and out to the undisturbed trench walls and uniformly tamped, avoiding any lateral displacement of the pipe. The initial backfill shall extend a minimum of 12 inches over the top of the pipe and shall be carefully and uniformly tamped. The final backfill shall be of excavated material containing no slabs or pieces of rock greater than 4 inches in maximum dimensions and shall be water settled or mechanically placed as approved by the Engineer. When completed, the final backfill shall be at the same elevation as the adjacent ground surface and shall be passable by conventional rubber tired vehicles without greater rutting than the adjacent natural ground.

Proper care shall be taken to avoid contact between the pipe and compaction equipment. Compaction equipment shall not be used directly over the pipe until sufficient backfill has been placed to assure that such equipment will not damage or disturb the pipe. At least 30 inches of backfill shall cover the pipe before the trench is wheel loaded and at

least 48 inches of backfill material shall be in place before compacting with a hydrohammer.

809-3.05 Iron Pipe:

Trench excavation for the iron pipe shall be no wider than is necessary for proper installation of the pipe.

The trench bottom shall be true and even in order to provide support for the full length of the pipe barrel. Holes for the bells shall be provided at each joint and shall be no larger than necessary for joint assembly and assurance that the pipe barrel will lie flat on the trench bottom.

If rock is encountered during trench excavation, all rock shall be removed to provide a clearance of at least 6 inches below and on each side of the pipe. After excavation of all rock, a 6-inch bed of soil which is free of stones, large clods or foreign matter shall be placed on the bottom of the trench, leveled and tamped.

The materials for pipe bedding, if required, and for the haunching and initial backfill for the iron pipe shall be soil free from stones, large clods or foreign matter. The backfill shall be placed completely under the pipe haunches and up each side of the pipe and uniformly tamped. The backfill shall be placed in lifts not exceeding 8 inches in depth, and each lift shall be compacted to at least 90 percent of maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. The final backfill shall be excavated material containing no slabs or pieces of rock greater than 4 inches in maximum dimension and shall be water-settled or mechanically placed as approved by the Engineer. When completed, the final backfill shall be at the same elevation as the adjacent ground surface and shall be passable by conventional rubber-tired vehicles without greater rutting than the adjacent natural ground.

809-3.06 Filter Fabric:

The installation of the filter fabric shall conform to the requirements of Subsection 208-3 of the specifications.

809-3.07 Inspection and Testing:

The inspection and testing of the sewer lines shall be performed following formal notice to the Engineer. The sewer lines shall be inspected, tested and accepted prior to being covered. All pipe and fittings will be carefully examined during the testing procedure. Any damaged or defective pipe or fittings that are discovered during or following testing shall be repaired or replaced with sound material and then retested until approved by the Engineer. The sewer line shall be tested by means of an exfiltration test. This test shall be conducted in accordance with the requirements as follows:

(A) Plug sewer line at lower end of section to be tested;

(B) Plug the highest end of the sewer line to be tested. The sewer plug shall have a suitable air vent to allow trapped air removal;

(C) Place a calibrated container at the average height of 4 feet above the flow line of the sewer line. Check the system for leaks in hoses, plugs, calibrated containers, etc., while filling through a positive shut-off valve. After filling the sewer line, allow one hour for absorption of water and refill sewer line. When the water overflows the calibrated container, close the input valve and begin the test;

(D) Record the elapsed time to empty the container of water and calculate the loss rate in gallons per hour; and

(E) The exfiltration rate from the sewer line shall not exceed 0.158 gallons per inch of pipe diameter per 100 feet of pipe length per hour with 4 feet of head.

809-4 Method of Measurement:

Sewerage systems will be measured either as a single complete unit of work or by the unit of measurement shown below and listed in the bidding schedule for the specified items:

(A) Septic tanks will be measured either as a single unit of work, complete, or as a unit for each tank constructed;

(B) Sewer pipe will be measured by the linear foot of pipe or as a single unit of work, complete, including excavating, backfilling, pipe, sand bedding and testing;

(C) Manholes will be measured in accordance with the requirements of Subsection 505-4 of the specifications; and

(D) Filter fabric will not be measured for payment.

809-5 Basis of Payment:

The accepted quantities of sewerage system, measured as provided above, will be paid for at the contract unit price specified in the bidding schedule, complete in place.

SECTION 810 EROSION CONTROL AND POLLUTION PREVENTION:

810-1 Description:

The work under this section shall include furnishing, installing, maintaining, removing and disposing of temporary erosion control measures such as silt fences, check dams, straw barriers, and other erosion control devices or methods as shown in the Storm Water Pollution Prevention Plan (SWPPP) and in the Special Provisions.

The work shall also include furnishing, installing, and maintaining permanent erosion control measures such as pipe inlet and outlet protection, cut and fill slope transitions, headwall and wingwall treatments, and other permanent erosion control devices or methods as shown in the SWPPP.

810-1.01 Erosion Controls:

Erosion controls, both temporary and permanent, shall be installed in accordance with phasing provisions in the approved SWPPP and coordinated with the related construction.

All work specified in this subsection will be temporary for use during construction, unless designated otherwise.

The contractor shall be responsible for maintaining all erosion and pollution control devices in proper functioning condition at all times.

When deficiencies in the erosion control devices or other elements of work listed herein are noted by inspection or other observation, specified corrections shall be made by the contractor by the end of the day or work shift, or as directed by the Engineer.

Work specified herein which is lost, destroyed, or deemed unacceptable by the Engineer as a result of the contractor's operations shall be replaced by the contractor at no additional cost to the Department. Work specified herein which is lost or destroyed as a result of natural events, such as excessive rainfall, shall be replaced by the contractor and be paid for in accordance with the requirements of Subsection 109.04 of the specifications.

In cases of serious or willful disregard for the protection of the waters of the U.S. and/or natural surroundings by the contractor, the Engineer will immediately notify the contractor of such non-compliance. If the contractor fails to remedy the situation within 24 hours after receipt of such notice, the Engineer may immediately place the erosion and/or other pollution control elements in proper condition and deduct the cost thereof from moneys due the contractor.

810-1.02 Other-Pollutants Controls:

The work shall include implementing controls to eliminate the discharge of pollutants, such as fuels, lubricants, bitumens, dust palliatives, raw sewage, wash water, and other harmful materials; into storm and other off-site waters. The work shall include the implementation of spill prevention and material management controls and practices to prevent the release or washoff of pollutants. These controls and practices shall be specified in the SWPPP and shall include storage procedures for chemicals and construction materials, disposal and cleanup procedures, the contractor's plans for handling of potential pollutants, and other pollution prevention measures as required.

Handling procedures for potential pollutants shall also be included in the contractor's "good housekeeping" practices, as specified in Subsection 104.09 of the Special Provisions.

810-2 Materials:

810-2.01 Silt Fence:

Material requirements for silt fences, including posts, wire support fencing, and fasteners, shall be in accordance with Section 915 of the specifications. Geotextile fabric shall conform to the requirements of Subsections 1014-1 and 1014-8 of the specifications, except that the filter cloth shall be woven polypropylene, and the fabric Apparent Opening Size shall be between numbers 20 and 50 U.S. Standard sieve sizes, when tested in accordance with ASTM D4751.

810-2.02 Compost Stabilization:

Compost stabilization shall consist of composted organic vegetative materials stabilized with a tacking agent and used for erosion control.

Compost material shall be dark brown in color with the parent material composted and no longer visible. The structure shall be a mixture of fine and medium size particles and humus crumbs. The maximum particle size shall be within the capacity of the contractor’s equipment for application to the constructed slopes. The odor shall be that of rich humus with no ammonia or anaerobic odors.

Compost shall also meet the following requirements:

COMPOST MATERIAL	
Cation Exchange Capacity (CEC)	Greater than 50 meq/100g
Carbon: Nitrogen Ratio	Less than 20:1
PH (of extract)	6 – 8.5
Organic Matter Content	Greater than 25%
Total Nitrogen (not added)	Greater than 1%
Humic Acid	Greater than 5%

Maturity Index	Greater than 50% on Maturity Index at a 10:1 ratio
Stability	Less than 100 mb 02/Kg compost dry solids – hour

Prior to furnishing on the project, compost mulch samples shall be tested for the specified microbiological and nutrient conditions, including maturity and stability, by a testing laboratory approved for testing of organic materials. Certified laboratory test results shall be submitted to the Engineer for approval.

Tacking agent shall be a naturally occurring organic compound and be non toxic. It shall be a product typically used for binding soil and mulch in seeding or erosion control operations. Approved types shall consist of mucilage or gum by dry weight as active ingredient obtained from guar or plantago. The tacking agent shall be labeled indicating the type and mucilage purity.

The contractor shall have the tacking agent swell volume tested by an approved testing laboratory using the USP method. The standard swell volume shall be considered at 30 milliliters per gram. Material shall have a swell volume of at least 24 milliliters per gram. Certified laboratory test results shall be furnished to the Engineer for each shipment of homogenous consistency to be used on project areas or as directed by the Engineer. Tacking agent rates shall be adjusted to compensate for swell volume variation. Material tested with lesser volume shall have the tacking agent rate increased by the same percentage of decrease in swell volume from the standard 30 milliliters per gram. Material tested with greater volume may reduce tacking agent rates by the same percentage of increase in swell volume from the standard 30 milliliters per gram. Tacking agent shall be pure material without other starches, bentonite, or other compounds that would alter the swell volume test results of mucilage, or the effectiveness of the tacking.

810-2.03 Riprap and Rock Mulch:

Riprap for cut and fill transitions designated on the plans shall be angular in shape and shall conform to the requirements of Section 913 of the specifications. Unless otherwise specified, riprap for cut and fill transitions shall conform to gradation A or B in the table below, as designated on the project plans.

Sieve Size		Percent Passing
Gradation A	Gradation B	
6 inch	12 inch	90 - 100
4.24 inch	9 inch	70 - 85
3 inch	6 inch	30 - 50
2 inch	4 inch	5 - 15
1 inch	2 inch	0 - 5

Rock mulch for pipe inlet and outlet protection, headwall and wingwall treatment, and rock check dams shall be angular in shape and shall conform to the requirements of Section 803 of the specifications. Rock mulch shall be in accordance with gradation C below, unless otherwise specified. Section 803 of the specifications requirements for use of pre-emergent herbicide and for post-placement watering of rock mulch shall not apply to rock mulch applied under Section 810 of the specifications.

Gradation C Rock Mulch (fractured/crushed rocks in angular shape)	
Sieve Size	**Percent Passing**
3.75 inch	100
2.5 inch	50 - 75
2 inch	30 - 50
1 inch	10 - 20

810-2.04 Sand Bags:

Sand bags, when filled, shall measure approximately 24 inches long by 16 inches wide by 4 inches thick. Bags shall be manufactured from polypropylene, polyethylene, or polyamide woven fabric with the following characteristics:

Unit Weight, Minimum, oz. per sq. yd.	4
Mullen Burst Strength:, Exceeding, psi	300
Ultraviolet Stability, Exceeding, %	70

Material used to fill sand bags shall be clean sand or a clean sandy soil free of silt, as approved by the Engineer.

810-2.05 Erosion Control Blankets:

(A) General:

Erosion control blankets shall consist of temporary, degradable, rolled erosion-control products of short-term or extended-term duration, composed of natural fibers mechanically or structurally bound together with natural or polymer netting to form a continuous matrix.

Erosion control blankets of short-term duration shall have a minimum one-year degradation period for both the netting and fibers, and be composed of 100 percent virgin aspen excelsior wood fibers or 100 percent agricultural straw. Extended-term erosion control blankets shall have a minimum two-year degradation period for the netting and fibers, and be composed of heavy-duty excelsior blankets, or a mix of 70 percent straw and 30 percent coconut fibers, or 100 percent coconut fibers. Heavy-duty excelsior blankets used in the extended-term category shall have a minimum weight of 0.7 pounds per square yard. All other types of blankets, whether for short-term or extended-term use, shall have a minimum weight of 0.5 pounds per square yard.

Fibers for short-term erosion control blankets shall be encased top and bottom with photodegradable polypropylene or 100-percent biodegradable natural organic fiber netting, as specified on the plans. Should the plans not specify type of netting for short-term blankets, fibers shall be encased with photodegradable polypropylene. Fibers for extended-term blankets shall be encased within either a heavy duty UV-stabilized top netting (black) and bottom netting (green), or two UV-stabilized nettings (black). All netting for extended-term blankets shall be photodegradable polypropylene.

Erosion control blankets shall also conform to the following requirements:

Property	Test Method	Short-Term Duration	Extend-Term Duration
Minimum mass per unit area (ounces/sq. yd.)	ASTM D6475	8	8*
Minimum Thickness** (inches)	ASTM D5199	0.25	0.25
Minimum Tensile Strength (lbs./ft) ***	ASTM D5035	75x75	100x100

Notes:

*Heavy duty blankets shall have a minimum mass per unit area of 11 ounces per square yard.
**Numerical value represents total thickness of blanket, including netting.
***Numerical value represents minimum average test result in either direction.

The contractor shall provide Certificates of Analysis, in accordance with Subsection 106.05 of the specifications, for all erosion control blankets.

Fiber color shall be natural unless otherwise specified in the special provisions.

Fibers shall be free of weed seed, and shall be locked in place to form a mat of consistent thickness. Erosion control blankets using straw shall conform to the requirements of Subsection 810-2.05(B) of the specifications. Fibers shall remain evenly distributed over the entire area of the blanket after being placed on the slope.

Erosion control blankets shall be furnished in 4-foot to 8-foot wide rolls, and shall be wrapped with suitable material to protect against moisture and extensive ultraviolet exposure prior to placement.

Each roll shall be labeled to provide sufficient identification for quality control purposes.

Staples shall be U-shaped, 11 gauge steel wire, and shall be 1 inch wide by 6 inches long or 2 inches wide by 8 inches long.

(B) Straw Certification:

All wheat straw shall be free from noxious weeds in compliance with the standards and procedures of the Arizona Crop Improvement Association (ACIA) or the North American Weed Management Association (NAWMA). The contractor shall provide documentation that the product containing wheat straw was manufactured solely from straw certified as free of noxious weeds by the ACIA or NAWMA. Such certification shall be provided to the Engineer prior to delivery of the products to the project site. Products using wheat straw without such certification will not be acceptable.

810-2.06 Sediment Logs, Sediment Wattles, and Fiber Rolls:

(A) General:

Sediment logs, sediment wattles, and fiber rolls shall be manufactured or constructed rolls of fiber matrix, secured with netting, and used for the purpose of controlling erosion by slowing high flow water velocity and trapping silt sediments. Netting for fiber rolls and sediment wattles shall have a minimum durability of one year after installation, and shall be tightly secured at each end of the individual rolls. All wheat straw used in sediment logs, sediment wattles, and fiber rolls shall comply with the requirements of Subsection 810-2.05(B) of the specifications.

The unit weight for wattles and fiber rolls shall be 0.144 pounds per inch of diameter per linear foot. Sediment log unit weight shall be 0.167 pounds per inch of diameter per linear foot. The minimum weight per linear foot for sediment logs, wattles, and fiber rolls shall be determined by multiplying the specified diameter of the device by the appropriate unit weight, in pounds per inch of diameter per linear foot, as specified above.

Netting at each end of sediment logs and wattles shall be secured with metal clips or knotted ends to assure fiber containment.

(B) Sediment Logs:

Sediment logs shall be constructed of 100 percent curled-fiber aspen wood excelsior with interlocking barbs, and with 80 percent (±10 percent) of the fiber at least 6 inches in length. Netting shall consist of long-term degradable, open weave, plastic or natural fiber containment mesh, with a maximum 1-inch by 1-inch grid. Sediment logs may also be filled with compost conforming to the requirements of Subsection 810-2.02 of the specifications. Mesh shall be photodegradable or biodegradable with a life expectancy of 12 to 24 months. Sediment logs shall be twenty inches in diameter. Unless approved by the Engineer, sediment logs shall be 10 feet (±10 percent) in length.

(C) Sediment Wattles:

Sediment wattles shall be manufactured rolls composed of weed-free, 100-percent agricultural wheat or rice straw, or excelsior wood fiber, encased in a tube of long-term photodegradable plastic or biodegradable natural fiber netting with a maximum 1-inch by 1-inch grid. Sediment wattles shall have nominal diameters of 9, 12, or 18 inches, with lengths from 7 to 25 feet, as specified on the plans. Fibers shall be evenly distributed throughout the wattle.

Wattles composed of wheat straw shall conform to the requirements of Subsection 810-2.05(B) of the specifications. Wheat straw wattles without the specified certification will not be acceptable.

(D) Fiber Rolls:

Fiber rolls shall be constructed from heavyweight manufactured blankets consisting of wood excelsior, straw, or coconut fibers, or any combination of such fibers, mechanically or structurally bound together with natural or polymer netting to form a continuous matrix. Blankets used to construct fiber rolls shall be between 6.5 and 8 feet wide by approximately 50 feet long. Wood excelsior blankets shall have 80 percent of its fibers equal to or greater than 6 inches. Blankets used to construct the fiber rolls shall have photodegradable plastic or biodegradable natural netting, with a maximum 1-inch by 1-inch grid, on at least one side.

Fiber rolls containing any amount of wheat straw shall conform to the requirements of Subsection 810-2.05(B) of the specifications. Fiber rolls with wheat straw that are not certified as specified herein will not be acceptable.

The contractor shall produce fiber rolls by rolling the blankets along their width to produce 50-foot lengths, and securing the rolls with jute twine spaced at 6.5-foot intervals along the roll for the full length and at 6 inches from each end. If shown on the plans or directed by the Engineer, the contractor shall cut the blankets before rolling to produce completed fiber roll lengths of between 14 and 50 feet. The nominal diameter of the finished rolls shall be 9, 12, or 18 inches, as specified on the plans. Overlapping of more than one blanket may be required to achieve larger diameters. When overlapping is required, the end of one blanket shall overlap 6 inches onto the end of the next blanket prior to rolling.

810-2.07 Sediment Control Berms:

Sediment control berms shall consist of soil obtained from within the project limits, or compost, or both, as called for on the plans.

Compost and tacking agent used in sediment control berms shall conform to the material requirements of Subsection 810-2.02 of the specifications.

810-3 Construction Requirements:

The contractor shall implement the SWPPP throughout the project, as specified in Subsection 104.09 of the Special Provisions.

Erosion control features shall be temporary or permanent, as designated herein. Temporary erosion control features specified for removal at the end of the project shall become the property of the contractor, unless designated by the Engineer to be left for permanent use.

810-3.01 Silt Fences:

Installation and maintenance requirements for silt fences shall be accordance with Section 915 of the specifications, unless otherwise specified.

810-3.02 Compost Stabilization:

Compost stabilization shall be applied as shown on the plans or as directed by the Engineer.

810-3.03 Riprap and Rock Mulch:

Riprap used in cut and fill transitions; and rock mulch treatments for pipe inlets and outlets, headwalls and wingwalls, and rock check dams; shall be installed in accordance with the project plans and details or as directed by the Engineer.

Rock shall be installed so as to conform to and completely cover the treatment area shown on the plans with a uniform, cohesive rock unit. The rock shall not impede flow into the treatment area and shall be feathered at the outflow.

Accumulated debris shall be removed and disposed of by the contractor after each rain storm, or as directed by the Engineer.

Pipe treatments, headwall and wingwall treatments, and cut and fill transitions are permanent project features which shall remain in continuous service after installation and project completion.

Rock check dams shall remain in service until the seeding work commences or until they are no longer needed, as approved by the Engineer. When use of a rock check dam is discontinued, the materials shall be removed and wasted on site in a manner that will not impede designed drainage flows, as approved by the Engineer.

810-3.04 Sand Bags:

The work shall include furnishing sand bags and sand, preparing the filled bags, and installing filled sand bags where shown on the plans or as approved by the Engineer.

Sand bags in the vicinity of curbs and catch basins shall be installed to 2 inches below the height of the adjacent curb to allow drainage into the catch basin. When sediment depth behind the sand bags reaches 3 inches, the sediment shall be removed and disposed of in accordance with local, state, and federal laws and permit requirements.

Sand bag features shall remain in service until disturbed areas have been stabilized, as directed by the Engineer.

When the use of a sand bag feature is discontinued, all materials shall be removed and become the property of the contractor. During removal, all sediment shall be disposed of, and the area restored to a finished condition as shown on the plans, or as directed by the Engineer.

810-3.05 Erosion Control Blankets:

(A) General:

Erosion control blankets shall be installed in accordance with the project plans and details, or as directed by the Engineer in accordance with the manufacturer's instructions.

For slope installations short-term duration blankets, as specified in Subsection 810-2.05 of the specifications, shall be used for slopes from 4:1 (horizontal to vertical) to 2:1. Extended-term blankets shall be used for slopes steeper than 2:1. For channel installations erosion control blankets shall conform to the requirements for extended-term duration.

The contractor shall coordinate with the blanket supplier for a qualified representative of the blanket supplier to be present at the job site at the start of installation to provide technical assistance as needed.

(B) Slope Installations:

Erosion control blankets shall be oriented in vertical strips and anchored with 6-inch long staples in cohesive soil and 8-inch long staples in non-cohesive soil. A 2-to-5 inch overlap, or as required by the manufacturer, shall be required for side seams. A 6-inch overlap, shingle-style, shall be required for blanket ends. The distribution of staples shall be as recommended by the manufacturer. A 6-inch deep by 6-inch wide trench shall be located at the top of the slope. The erosion control blankets shall be stapled to the bottom of the trench with staples spaced 6 inches apart across the width of the blanket. The trench shall then be backfilled and compacted.

(C) Channel Installations:

For channel installations, erosion control blankets shall be installed parallel to the flow of water. The first blanket shall be centered longitudinally in mid-channel and anchored with staples, as recommended by the manufacturer. Subsequent blankets shall follow from channel center outward.

The distribution of staples shall be as recommended by the manufacturer.

Successive lengths of erosion control blankets shall be overlapped a minimum of 6 inches with the upstream end on top. Staple the overlap across the end of the overlapping lengths with staples spaced 6 inches apart.

A 6-inch deep by 6-inch wide trench shall be located at the upstream and top of side slope terminations of the blankets. The erosion control blankets shall be stapled to the bottom of the trench, with staples spaced 6 inches apart across the width of the blanket. The trench shall be backfilled and compacted.

810-3.06 Sediment Logs, Sediment Wattles, and Fiber Rolls:

(A) Sediment Logs:

Sediment logs shall be installed in channel bottoms, around catch basins, as check dams, or on slopes, as shown on the plans or as directed by the Engineer in accordance with the manufacturer's instructions. Sediment logs shall be secured with 1-inch by 1-inch by 46-inch hardwood stakes placed with a maximum spacing of 2 feet on center, or as shown on the plans. Each stake shall be intertwined with the netting on the downstream side of the log and driven approximately 2 feet below finished grade. Unless otherwise specified, soil shall be tamped against the upstream side of the log to assure that storm water is forced to flow through the log rather than under it.

Sediment logs installed in drainage channel bottoms shall be perpendicular to the flow of the water, and shall continue up the channel side slope 2 feet above the high water flow line. Spacing of the logs shall be as specified in the plans.

When sediment logs are used to construct check dams, the logs placed on the ground shall be buried 4 to 6 inches deep as shown on plans.

Logs placed on slopes shall be installed in a 2 inch deep by 5 inch wide anchor trench. The ends of adjacent logs shall be abutted tightly together so that water cannot undermine the logs.

(B) Sediment Wattles:

Sediment wattles shall be installed on slopes as shown on the plans, and in accordance with the manufacturer's instructions, or as directed

by the Engineer. Sediment wattles shall be secured with wooden stakes as shown on the plans. The ends of adjacent wattles shall be abutted tightly together.

(C) Fiber Rolls:

Fiber rolls shall be installed on slopes as shown on the plans, and in accordance with the manufacturer's instructions, or as directed by the Engineer. If no spacing is shown on the plans, fiber rolls shall be placed as specified in the table below. Fiber rolls shall be installed in a 2-inch deep by 5-inch wide anchor trench. Fiber rolls shall be secured with wooden stakes having a 3/4-inch by 3/4-inch minimum cross-sectional dimension and 3-foot minimum length, or as shown on the plans. Each stake shall be driven through the center of the finished fiber roll, spaced a maximum of 3 feet apart, and driven approximately 2 feet into the ground. The ends of adjacent rolls shall be abutted together.

Fiber Roll Spacing Table	
Slope (Horizontal to Vertical)	**Spacing (feet)**
Less than 6:1	50
6:1 to 4:1	25
Greater than 4:1 and less than 2:1	17
2:1 to less than 1:1	10
1:1 and greater	5

810-3.07 Sediment Control Berms:

Sediment control berms shall be installed as shown on the plans. The berm shall be considered a temporary erosion control protection measure. As directed by the Engineer, the contractor shall remove segments of the berm within areas that have been successfully re-vegetated prior to allowing traffic operations.

810-4 Method of Measurement:

Silt Fence will be measured in accordance with Subsection 915-5 of the specifications.

Compost stabilization will be measured by the cubic yard of applied and tacked compost material.

Pipe Inlet/Outlet Treatment, Headwall and Wingwall Treatment, and Rock Check Dams will be measured per cubic yard of rock mulch. Cut and Fill Transitions will be measured per cubic yard of riprap.

Sand bags will be measured per each filled sand bag placed into service.

Erosion control blankets will be measured by the square yard of total ground area covered.

Sediment logs, sediment wattles, and fiber rolls will be measured by the linear foot.

Sediment control berms will be measured by the linear foot along the center line of the berm, parallel to the ground surface.

810-5 Basis of Payment:

Silt Fence will be paid for in accordance with Subsection 915-6 of the specifications, except that no separate measurement and payment will be made for removal of sediment, the cost being considered a part of contract items.

The accepted quantity of rock check dams, measured as provided above, will be paid for at the contract unit price per cubic yard of rock mulch, which price shall be full compensation for the work, complete in place, including all excavation; preparation; and furnishing, installing, maintaining, final removal, and disposal or dispersion, including returning the area to a natural condition, as approved by the Engineer.

The accepted quantity of Pipe Inlet/Outlet Treatment, measured as provided above, will be paid for at the contract unit price per cubic yard of rock mulch, which price shall be full compensation for the work, complete in place, including all excavation; preparation; and furnishing, installing, and maintaining of Pipe Inlet/Outlet Treatment, as approved by the Engineer.

The accepted quantity of Headwall and Wingwall Treatment, measured as provided above, will be paid for at the contract unit price per cubic yard of rock mulch, which price shall be full compensation for the work, complete in place, including all excavation; preparation; and furnishing, installing, and maintaining of Headwall and Wingwall Treatment, as approved by the Engineer.

The accepted quantity of Cut and Fill Transitions, measured as provided above, will be paid for at the contract unit price per cubic yard of riprap, which price shall be full compensation for the work, complete in place, including all excavation; preparation; and furnishing, installing, and maintaining of Cut and Fill Transitions, as approved by the Engineer.

The accepted quantities of sand bags, measured as provided above, will be paid for at the contract unit price per each sand bag, which price shall be full compensation for the work, complete in place, including all excavation; preparation; and furnishing, installing, maintaining, final removal, and disposal of temporary sand bags, including returning the area to a natural condition, as approved by the Engineer. No separate measurement and payment will be made for removal of sediment, the cost being considered a part of contract items.

The accepted quantities of erosion control blankets, measured as provided above, will be paid for at the contract unit price per square

yard, which price shall be full compensation for the work, complete in place, including all excavation and preparation; and furnishing, installing, and maintaining the erosion control blankets, as approved by the Engineer. Such unit bid price shall be considered full compensation for either short-term or extended-term blankets. No additional payment will be made for technical assistance provided by representatives of the blanket supplier, the cost being considered as included in the unit bid price.

The accepted quantities of sediment logs, sediment wattles, and fiber rolls, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for all labor, including excavation, preparation, and installation, and all materials, tools, stakes, equipment, and incidentals necessary for furnishing and installing the devices, complete in place, as approved by the Engineer. No additional payment will be made for sediment logs used as check dams, the cost being considered as included in the unit bid price paid for sediment logs.

The accepted quantities of compost stabilization, measured as provided above, will be paid for at the contract unit price per cubic yard of compost material applied and tacked, as directed by the Engineer. Such price shall be full compensation for the work, complete in place, including all materials, preparation, installation, tacking, maintenance, and removal of the compost-stabilization area.

The accepted quantities of sediment control berms, measured as provided above, will be paid for at the contract unit price per linear foot, regardless of the type of material used. Such price shall be full compensation for the work, complete in place, including all materials, preparation, compaction, installation, and maintenance, and removal of the sediment control berm.

No additional measurement or payment will be made for temporary features subsequently designated by the Engineer as permanent, the cost being considered as included in the unit bid price.

No additional measurement or payment will be made for associated earthwork, ground preparation, overlapping, stakes, silt and debris removal and disposal, or maintenance, the cost being considered as included in the unit bid price.

SECTION 901 MOBILIZATION:

901-1 Description:

The work under this section shall consist of preparatory work and operations, including but not limited to, the movement of personnel, equipment, supplies and incidentals to the project site; the establishment of all offices, buildings and other facilities necessary for work on the project, and for all other work and operations that must be performed and costs incurred prior to beginning work on the various items on the project site.

901-2 Blank:

901-3 Blank:

901-4 Method of Measurement:

Mobilization will be measured for payment by the lump sum as a single complete unit of work.

901-5 Basis of Payment:

Payment for mobilization, measured as provided above, will be made at the contract lump sum price, which shall be full compensation for supplying and furnishing all materials, facilities and services and performing all the work involved as specified herein.

Partial payments under this item will be made in accordance with the following provisions. Reference herein to the adjusted contract shall mean the original contract amount exclusive of mobilization:

(A) The first payment of the lump sum price for mobilization will be paid after the Preconstruction Conference provided that all submissions required under Subsection 108.03 of the specifications are submitted by the contractor at the Preconstruction Conference to the satisfaction of the Engineer. The amount paid for the first partial payment will be in accordance with Table 901-1;

(B) The second payment of the lump sum price for mobilization will be made when the Engineer has determined that a significant amount of equipment has been mobilized to the project site which will be used to perform portions of the contract work. The amount paid for the second partial payment will be in accordance with Table 901-1;

(C) The third payment of the lump sum price for mobilization will be made on the first estimate following completion of 5 percent of the adjusted contract. Such percentage

determination will not include partial payments for material on hand. The amount paid for the third payment will be in accordance with Table 901-1;

(D) The fourth payment of the lump sum price for mobilization will be made on the first estimate following completion of 10 percent of the adjusted contract. Such percentage determination will not include partial payments for material on hand. The amount paid for the fourth payment will be in accordance with Table 901-1; and

(E) The total sum of all payment shall not exceed the original contract lump sum price for mobilization, regardless of the fact that the contractor may have, for any reason, shut down its work on the project or moved its equipment away from the project and back again.

TABLE 901-1
AMOUNT ALLOWED FOR MOBILIZATION DURING THE LIFE OF THE CONTRACT

Contract Amount: $	% Of Contract	Basis of Payment
0 - 5,000,000	12% *	25% of the lump sum price for mobilization or 3% of the original contract amount, whichever is less.
5,000,000 +	10% *	25% of the lump sum price for mobilization or 2.5% of the original contract amount, whichever is less.

Note:

* If the price bid for mobilization exceeds this percentage, any excess will be paid to the contractor upon completion of the contract.

The adjustment provisions in Section 104 of the specifications and the retention of funds provisions in Section 109 of the specifications shall not apply to the item of mobilization.

When other contract items are adjusted as provided in Section 104 of the specifications, and if the costs applicable to such items of work include mobilization costs, such mobilization costs will be considered as recovered by the contractor in the lump sum price paid for mobilization, and will be excluded from consideration in determining compensation under Section 104 of the specifications.

When mobilization is not included as a contract item, full compensation for any necessary mobilization required will be considered as included in the prices paid for the various contract items involved and no additional compensation will be made.

SECTION 902 CHAIN LINK FENCE:

902-1 Description:

The work under this section shall consist of furnishing all materials and constructing chain link fence and gates at the locations and in accordance with the details shown on the plans. Chain link fence shall be either Type 1 or 2 and shall be constructed in accordance with the requirements of these specifications.

The type and height of chain link fence to be constructed will be shown on the project plans.

Chain link fabric shall be constructed of either zinc-coated steel or aluminum-coated steel. Posts, hardware and fittings shall be either zinc-coated steel or aluminum-coated steel. The option used shall be the same on any one project.

The work under this section shall also include constructing chain link fence and gates from salvage.

902-2 Materials:

902-2.01 General:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for all materials except for Subsection 902-2.08 of the specifications. Barbed Wire will be sampled and tested in accordance with methods used by the Department and will require written approval by the Engineer prior to being incorporated into the work.

902-2.02 Posts:

(A) General:

Posts shall be round pipe, H-section or roll-formed and shall conform to the nominal dimensional requirements shown on the plans. In addition, the material of which posts are fabricated shall have a nominal thickness, before galvanizing, of not less than 0.111 inches. The option of post type used shall be the same on any one project.

Posts shall have provisions to securely hold the top tension wire in position and allow for removal and replacement of a post without damaging the top tension wire. Tubular posts shall be fitted with rain-proof tops.

(B) Round Pipe:

Pipe shall be zinc-coated (galvanized) round steel pipe conforming to the requirements of ASTM A53, Type E or S, Grade A, Standard Weight, Schedule 40 or shall be round pipe conforming to all of the requirements of AASHTO M 181 for Grade 2 pipe. In addition, Grade 2 pipe furnished with an organic topcoat shall have a separate chromate chemical treatment of 15 micrograms per square inch applied to the zinc coating prior to application of the organic topcoat.

(C) H-Section Posts:

H-section posts shall be manufactured from steel conforming to the minimum requirements of AASHTO M 223, Grade 42, and shall meet the zinc coating, strength and dimensional requirements of AASHTO M 181 for Type I, Grade 1 steel posts.

(D) Roll Formed Posts:

Roll formed posts shall be manufactured from steel sheet and strip conforming to the minimum requirements of ASTM A570, Grade 45 and shall meet the strength and dimensional requirements of AASHTO M 181 for Type I roll-formed posts. The required coating shall be a hot-dip zinc coating in accordance with the requirements of AASHTO M 181 for Grade 1 steel posts or a coating system meeting the exterior coating requirements of AASHTO M 181 for Grade 2 round steel posts consisting of a hot-dip zinc coating, chromate chemical treatment, and organic topcoat.

902-2.03 Concrete:

Concrete for post footings shall be utility concrete conforming to the requirements of Section 922 of the specifications.

902-2.04 Fence Fabric:

Steel wire constituting the fence fabric shall meet the minimum breaking strength shown in Table 2 of AASHTO M 181 for Type I or II wire when tested in accordance with AASHTO T 68.

Chain link fence fabric shall be either zinc-coated or aluminum-coated steel wire fence fabric. Zinc-coated steel fabric shall conform to the requirements of ASTM A392, Class 1 coating. Aluminum-coated steel fabric shall conform to the requirements of ASTM A491, with a minimum weight of coating of 0.40 ounces per square foot of wire surface area. The wire used for aluminum-coated chain link fence fabric shall be coated before weaving into fabric. The wire used in the manufacture of the fabric shall be 11 gauge for all fence fabric 60 inches or less in height and shall be nine gauge for fabrics greater than 60 inches in height.

Chain link fence fabric shall be woven throughout in the form of approximately 2-inch square mesh. Fabric 60 inches or less in height shall be furnished with knuckling on one selvage and barbing on the other, and fabric over 60 inches shall be furnished with barbing on both selvages.

902-2.05 Tension Wire and Fabric Fasteners:

Tension wire shall be seven gauge (0.177 inch diameter) coil spring steel wire of good commercial quality with a minimum tensile strength of 75,000 pounds per square inch, and shall be zinc-coated or aluminum-coated. Zinc-coated steel wire shall have a minimum coating of 0.8 ounces per square foot of uncoated wire surface. Aluminum-coated steel wire shall have a minimum coating of 0.4 ounces per square foot of uncoated wire surface.

Tie wires, hog rings and post clips shall be zinc-coated or aluminum-coated steel of good commercial quality and shall be of the same diameter and breaking strength as the fence fabric being fastened. The minimum weight of zinc-coating shall conform to the requirements of ASTM A641, Class 3. The minimum weight of aluminum coating shall be 0.4 ounces per square foot of wire surface area.

902-2.06 Truss Rods and Tighteners:

Truss rods and tighteners shall be fabricated from commercial quality steel and shall be zinc-coated in accordance with the requirements of AASHTO M 111. Truss rods shall be 3/8-inch diameter adjustable rods. Truss tighteners shall have a strap thickness of not less than 1/4 inch.

902-2.07 Miscellaneous Fittings and Hardware:

Structural bars, stretcher bar bands, post caps and miscellaneous hardware shall be fabricated from commercial quality steel and shall be zinc-coated in accordance with the requirements of AASHTO M 111. Stretcher bars shall be 3/16-inch by 3/4-inch steel flat bars. Stretcher bar bands shall be 1/8-inch by 1-inch preformed steel bands.

902-2.08 Barbed Wire and Barbed Wire Support Arm:

Barbed wire for use with Type 2 chain link fence shall conform to the requirements of Subsection 903-2.04(A) of the specifications.

Barbed wire support arm shall be of the type shown on the plans, shall be fabricated from commercial quality steel, and shall be zinc-coated in accordance with the requirements of AASHTO M 111.

902-2.09 Gates:

Gates shall be of the sizes shown on the plans. Gates greater than 8 feet in width shall have a vertical member installed at the midway point of the gate.

Gate frames shall be constructed of not less than 1-1/2 inch steel pipe and interior vertical members shall be constructed of not less than 1-inch pipe. Pipe shall be zinc-coated steel pipe conforming to the requirements of ASTM A53, Standard Weight, Schedule 40, or shall be round pipe conforming to all of the requirements of AASHTO M 181 for Class 2 pipe.

Gate frames shall be fastened together at the corners by welding. Welding shall be performed in accordance with the requirements of the American Welding Society, Structural Welding Code, D1.1-80 and as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

Truss rods and tighteners for the gate frames shall conform to the requirements specified herein under Subsection 902-2.05 of the specifications.

Fabric for the gates shall be of the same kind used for the adjoining chain link fence and shall be attached to the gate frame by the use of stretch bars, stretcher bands and tie wires as specified under Subsection 902-3.03 of the specifications.

Gates shall be hung by at least two steel, ductile iron or malleable iron hinges not less than 3 inches in width, so designed as to securely clamp to the gate post and permit the gate to be swung back against the fence.

Gates shall be provided with a combination steel, ductile iron or malleable iron catch and locking attachment which will not rotate around the latch post. Stops to hold gates open shall be provided where required.

902-3 Construction Requirements:

902-3.01 General:

In areas where there is livestock, the contractor shall take all measures necessary to restrict the livestock to the land where it is being kept. The contractor shall furnish all materials and construct temporary fence, gates and cattle guards as may be necessary to restrict the livestock as specified.

Existing fences that are to remain in place and which have been damaged by the contractor's operations shall be replaced or restored by the contractor at no additional cost to the Department in accordance with the provisions of Subsection 107.12 of the specifications.

The contractor shall clear the fence lines of all earth, trees, brush and other obstructions which interfere with the proper construction of the fences, unless the Engineer orders certain trees to remain in place. Disposal of removed material shall be in accordance with the requirements of Subsection 201-3.02 of the specifications. Clearing the fence line shall be within the highway right-of-way. Fence shall be constructed within the highway right-of-way as shown on the plans.

902-3.02 Setting Posts:

Line posts shall be spaced at not more than 10-foot intervals measured from center to center of posts and such measurement shall be made parallel to the slope of the natural ground.

End, intermediate and corner post assemblies shall be as shown on the plans. Intermediate post assemblies shall be spaced at 500-foot intervals or midway between pull posts when the distance between such posts is less than 1,000 feet and more than 500 feet.

All posts shall be placed in a vertical position, except in unusual locations where the Engineer may direct that the posts be set perpendicular to the ground surface. All posts shall be set in concrete footings conforming to the details shown on the plans and crowned at the top to shed water.

Fence fabric or wire shall not be attached to the posts until the concrete has cured a minimum of 72 hours.

At locations where a change in the vertical alignment of the fence line forms an angle of deflection of 10 degrees or more, a corner post assembly shall be provided. A change in the horizontal alignment of the fence line where the angle of deflection is 30 degrees or more shall be considered as a corner and a corner post assembly shall be installed.

902-3.03 Installing Fence Fabric:

Chain link fence fabric shall be fastened on the outward facing side of the posts, unless otherwise specified by the Engineer. The fabric shall be stretched taut and fastened to the posts and between posts the top and bottom edges of the fabric shall be fastened to the tension wires. The tension wires shall be stretched tight and installed on a straight grade between posts. The distance from the top of the fabric to the top tension wire shall be 2 inches maximum.

The fabric shall be fastened to end, corner, latch, gate and pull posts with stretcher bars and stretcher bar bands. Stretcher bar bands shall be spaced at intervals not exceeding 14 inches. The fabric shall be fastened to the line posts with the wires or post clips spaced at intervals not exceeding 14 inches and to the tension wires with the wires or hog rings spaced at 18 inches center to center.

Selvage at bottom of chain link fence fabric shall be barbed, unless otherwise specified. Selvage at top of chain link fence fabric shall be barbed for heights over 60 inches, and shall be knuckled for heights 60 inches or less.

902-3.04 Barbed Wire:

Barbed wire for Type 2 fence shall be pulled taut before being permanently attached to the barbed wire extension arms and to the posts. Barbed wire across the top of a gate frame shall be made taut by means of eye bolts or ratchet bands at each end.

A maximum of two splices on barbed wire will be allowed between post assemblies but not on the same wire. No splicing will be allowed within 100 feet of a pull post.

902-3.05 Construct Chain Link Fence from Salvage:

Portions of the existing chain link fence, including gates, designated for removal and salvage shall be constructed at the new locations shown on the project plans and shall be constructed in accordance with the provisions specified herein for new chain link fence.

The contractor may, at its option and at no additional cost to the Department, construct new chain link fence in lieu of constructing chain link fence from salvage. If the contractor elects to construct new chain link fence, the fence materials originally designated for construction from salvage shall become the property of the contractor.

All posts, pipe, fabric or hardware which are deemed by the Engineer to be unsuitable for use in reconstructing the chain link fence shall be removed and disposed of as directed by the Engineer. If any of these materials require replacement to complete the quantity of chain link fence to be constructed, the materials shall be furnished by the contractor and will be paid for as specified in Subsection 109.04 of the specifications.

902-4 Method of Measurement:

Chain link fence will be measured by the linear foot of each type and size of fence specified. Measurement will be made along the top of the completed fence from outside to outside of end posts, excluding the widths of gate openings. Gate posts and latch posts will be considered as included in the measurement of the completed fence.

Gates will be measured by the unit of each type and size of gate specified. A gate unit complete in place shall include the necessary fittings, hardware, and gate bracing.

Constructing the various types of chain link fence or gates from salvage will be measured by the linear foot or by the unit each, using the limits of measurement specified for new construction.

902-5 Basis of Payment:

The accepted quantities of chain link fence and gates or construct chain link fence and gates from salvage, measured as provided above, will be paid for at the contract unit price per linear foot for the type and size of fence and per each for the type and size of gates designated in the bidding schedule, complete in place.

The accepted quantities of construct chain link fence from salvage, measured as provided above, will be paid for at the contract unit price per linear foot, complete in place, including excavation, footing concrete, backfill and disposal backfill and disposal of surplus material. Any new posts, pipe, fabric or hardware furnished by the contractor to replace salvaged chain link fence components deemed by the Engineer to be unsuitable for use, will be measured and paid for in accordance with the provisions of Subsection 104.02 of the specifications.

No payment will be made for furnishing materials and constructing temporary fence, gates and cattle guards as may be necessary to restrict livestock.

SECTION 903 WIRE FENCE:

903-1 Description:

The work under this section shall consist of furnishing all materials and constructing barbed wire fence, woven wire fence, game fence, antelope fence and gates at the locations and in accordance with the details shown on the plans. Fences and gates shall be of the types and sizes shown on the plans and shall be constructed in accordance with the requirements of these specifications.

The type of fence to be constructed will be shown on the project plans.

903-2 Materials:

903-2.01 General:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for all materials except for Subsection 903-2.02 of the specifications, Posts and Braces, and Subsection 903-2.04 of the specifications, Fencing Wire. Subsections 903-2.02 and 903-2.04 of the specifications will be sampled and tested in accordance with methods used by the Department and will require

written approval by the Engineer prior to being incorporated into the work.

903-2.02 Posts and Braces:

Line posts shall conform to the requirements of ASTM A702. Lengths of posts shall be as shown on the plans. Packaging of posts will not be required. The type of post furnished, tee, channel or U or Y type, shall be the same on any one project.

End, corner, pull, latch and gate posts and braces shall conform to the requirements of ASTM A702, for uprights and braces.

Posts and braces shall be painted green.

903-2.03 Concrete:

Concrete for post footings shall be utility concrete conforming to the requirements of Section 922 of the specifications.

903-2.04 Fencing Wire:

(A) Barbed Wire:

Barbed wire shall be 12-1/2 gauge steel wire with four-point 14-gauge barbs spaced 5 inches apart and shall be either zinc-coated (Class 1) or aluminum-coated, conforming to the requirements of ASTM A121.

(B) Barbless Wire:

Barbless wire shall meet the same requirements as barbed wire, except that the barbs shall be omitted.

(C) Woven Wire Fabric:

Woven wire fabric shall be No. 11 (Grade 60) woven steel fence fabric with stay wires spaced 6 inches apart and shall be either zinc-coated (Class 1) or aluminum-coated, conforming to the requirements of ASTM A116.

903-2.05 Stays and Fasteners:

Stays shall be 9-1/2 gauge twisted wire designed for screw-on type installation. Stays shall be zinc-coated steel of good commercial quality. The minimum weight of zinc-coating shall be 0.3 ounces per square foot of uncoated wire surface.

Tie wires, hog rings and post clips shall be zinc-coated steel of good commercial quality and shall be of the same diameter as the fence fabric being fastened.

The minimum weight of zinc-coating shall be 0.3 ounces per square foot of uncoated wire surface.

903-2.06 Gates:

(A) Type 1 Gate:

Gates shall conform to the requirements of Subsection 902-2.09 of the specifications, except as specified herein.

Gates greater than 5 feet in width shall have a vertical member installed at the midway point of the gate.

Fabric for the gates shall be either chain link fence fabric or woven wire fabric. Chain link fence fabric shall conform to the requirements of Subsection 902-2.04 of the specifications for fabric using 11 gauge wire. Woven wire fabric shall be of the same kind used for the adjoining woven wire fence. When the adjoining fence is barbed wire fence, gate fabric shall be of the kind used with Type 2 woven wire fence.

Gates shall be hung by at least two steel, ductile iron, or malleable iron hinges so designed as to securely clamp to the type of gate post furnished and permit the gate to be swung back against the fence.

Gates shall be provided with a combination steel, ductile iron, or malleable iron catch and locking attachment which will not rotate around the latch post. Stops to hold gates open shall be provided where required.

(B) Type 2 Gate:

Type 2 gates shall be constructed so that each line of wire will be securely attached to the gate post and to the latch board. The three vertical wire stays, placed within the gate, shall be equally spaced. Above the top fence wire and below the bottom fence wire, a double strand of steel wire shall be placed around the latch post forming loops of such size that they will accept the ends of the latch board. A pry stick shall be sewed to the gate post so as to draw the fence to a taut condition when closed.

The latch board and pry stick assembly shall be made of wood or of steel. Wood shall be clear select Douglas fir, 2 inch by 2 inch by 4 feet for the latch board and 2 inch by 2 inch by 2 feet for the pry stick. Steel latch board and pry stick shall be fabricated from the same type of steel utilized for line posts.

903-3 Construction Requirements:

903-3.01 General:

In areas where there is livestock, the contractor shall take all measures necessary to restrict the livestock to the land where it is being kept. The contractor shall furnish all materials and construct temporary fence, gates and cattle guards as may be necessary to restrict the livestock as specified.

Existing fences that are to remain in place and which have been damaged by the contractor's operations shall be replaced or restored by the contractor at no additional cost to the Department in accordance with the provisions of Subsection 107.11 of the specifications.

The contractor shall clear the fence lines of all earth, trees, brush and other obstructions which interfere with the proper construction of the fences, unless the Engineer orders certain trees to remain in place. Clearing the fence line shall be within the highway right-of-way. Disposal of removed material shall be in accordance with the requirements of Subsection 201-3.02 of the specifications.

Fence shall be constructed within the highway right-of-way as shown on the plans.

903-3.02 Setting Fence:

Fence posts shall be spaced at the intervals and set to the depths shown on the plans.

In determining the post spacing, measurements shall be made parallel to the ground slope, and all posts shall be placed in a vertical position, except in unusual locations where the Engineer may direct that the posts be set perpendicular to the ground surface.

Line posts may be driven into undisturbed earth provided driving does not injure the posts. All voids around the post shall be backfilled and the material thoroughly tamped.

End, corner, pull, latch and gate posts and braces shall be set in concrete footings crowned at the top to shed water.

Any high points which interfere with the placing of wire fence fabric shall be excavated to provide the clearance shown on the plans.

Changes in the horizontal alignment of the fence line where the angle of deflection is 15 degrees or more shall be considered as corners and a corner post assembly shall be installed. Changes in fence alignment where the angle of deflection is less than 15 degrees but more than 5 degrees shall be considered as alignment angles and diagonal tension

wires shall be installed. The diagonal tension wires shall consist of two twisted steel wires and shall be attached to the adjacent line posts.

Where the fence line intersects a cross fence, the wires of the existing cross fence shall connect to an end post assembly as shown on the plans.

Connecting fence assemblies with braces for every direction of strain shall be placed at the junction with new fences.

Intermediate post assemblies shall be installed at not more than 650-foot intervals between other braced posts, but for woven wire fence the spacing shall be such as to use standard rolls of fabric with a minimum of cutting and waste. After post assemblies have been placed, the barbed wire and woven wire fabric shall be pulled taut to the satisfaction of the Engineer, and each longitudinal wire shall be cut and securely fastened to the braced post with devices customarily used for the purpose. Barbed wire or woven wire fabric shall not be carried past a post assembly, but shall be cut and fastened to the post independently of the adjacent spans. A maximum of two splices on barbed wire will be permitted between post assemblies, but not on the same wire. No splice shall be placed closer than 100 feet to any post assembly.

Where fence lines are interrupted by openings for gates and cattle guards, intermediate post assemblies shall be installed at both sides of the opening at a distance of one panel width from the end of the opening.

After the tensioning of the barbed wire or woven wire fabric between two post assemblies, all longitudinal wires shall be attached to each intervening line post at the height and spacing as shown on the plans. The distance from the bottom wire to the ground may vary at any one point from that shown on the plans 4 inches plus or minus for barbed wire fence and game fence and 1 inch plus or minus for woven wire fence. Where abrupt changes occur in the fence line grade, intermediate line posts may be required to maintain proper distances between the bottom wire and the ground.

Spacing of the twisted vertical wire stays shall be as shown on the plans for each type of fence. The vertical wire stays shall be woven into every horizontal wire for each type of fence.

At all grade depressions where stresses tend to pull the posts from the ground, the affected fence posts shall be anchored in concrete or the fence wires shall be weighted with concrete sag weights. The volume of concrete required to anchor the posts shall be not less than 1 cubic foot. Fence sag weights shall weigh not less than 100 pounds and shall be made with a wire loop hanger embedded in the concrete. A double strand of wire shall be attached to each horizontal line of barbed wire and to the top and bottom wire of the woven wire fabric and tied to the wire loop hanger of the sag weight.

903-3.03 Flood Gates:

Flood gates shall be constructed at the locations specified on the project plans or where designated by the Engineer and in accordance with the details shown on the project plans. If the length of the flood gate is such that the Engineer determines that line posts are needed, the posts shall be placed as necessary and driven to the depth required to keep the flood gate upright.

Flood gates shall be constructed to the same requirements specified for barbed wire fence construction, except that the concrete sag weights shall weigh 35 pounds.

903-4 Method of Measurement:

Wire fence will be measured by the linear foot of each type of fence specified. Measurement will be made along the top of the completed fence from outside to outside of end posts, excluding the widths of gate and cattle guard openings. Gate posts and latch posts will be considered as included in the measurement of the completed fence.

Type 1 gates will be measured as a complete unit in place by the width of the gate opening. Double gates will be measured as one complete unit by the width of the gate opening. A gate unit complete in place shall include the gate with all necessary fittings, hardware, and gate bracing.

Type 2 gates will be measured as a complete unit in place by the width of the gate opening. A gate unit complete in place shall include the wire gate with vertical stays, latch board and pry stick.

Flood gates will be measured by the linear foot. Measurement will be made on the fence line along the top wire from gate post to gate post as shown on the plans, but exclusive of any Type 2 gates.

903-5 Basis of Payment:

The accepted quantities of wire fence and flood gates, measured as provided above, will be paid for at the contract unit price per linear foot for the type of fence and gate designated in the bidding schedule, complete in place.

Types 1 and 2 gates, measured as provided above, will be paid for at the contract unit price per gate for the type designated in the bidding schedule, complete in place.

No payment will be made for furnishing materials and constructing temporary fence, gates and cattle guards as may be necessary to restrict livestock.

SECTION 904 CHAIN LINK CABLE BARRIER:

904-1 Description:

The work under this section shall consist of furnishing all materials and constructing chain link cable barrier fence at the locations and in accordance with the details shown on the project plans and in accordance with the requirements of the plans and these specifications.

904-2 Materials:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

The wire rope and swaged connection assembly and the associated nuts and washers shall conform to the requirements for the cable assembly specified under Subsection 1012-2 of the specifications, except that the length of the wire rope and the stud bolts shall be as shown on the project plans, and the wire rope shall conform to the requirements of AASHTO M 30, Class B, Type II.

Concrete shall be Class S Portland cement concrete conforming to the requirements of Section 1006 of the specifications.

Welded wire fabric shall conform to the requirements of Section 1003 of the specifications.

The chain link fence fabric, ties, fasteners, hardware and other fittings shall be of the dimensions shown on the project plans and shall conform to the requirements of Subsection 902-2 of the specifications.

All structural steel shall conform to the requirements of ASTM A36, except that the anchor plate shall be made of steel conforming to the requirements of ASTM A572 or ASTM A588. All structural steel shall be galvanized in accordance with the requirements of ASTM A123.

904-3 Construction Requirements:

In addition to the requirements of this section, the construction of the chain link cable barrier shall conform to the applicable requirements of Section 902 and Section 905 of the specifications.

The excavation for the concrete anchor block shall be to the neat lines shown on the project plans, with a maximum of 3 inches outside those lines. The entire volume of the excavation shall be filled with concrete.

The chain link cable barrier shall be constructed at the location shown on the project plans and to the lines and grades established by the Engineer. The chain link fence and cables shall follow the contours of

the finished ground surface. The cables shall have only enough tension to prevent them from sagging more than 1 inch between clamps.

904-4 Method of Measurement:

Chain link cable barrier will be measured by the linear foot along the top strain wire from center to center of the fence post at each end.

904-5 Basis of Payment:

The accepted quantities of chain link cable barrier, measured as provided above, will be paid for at the contract unit price per linear foot, complete in place, including excavating, furnishing and placing concrete and reinforcing steel for the footings, disposal of surplus material, and grading immediately adjacent to the barrier.

SECTION 905 GUARDRAIL:

905-1 Description:

The work under this section shall consist of furnishing all labor, equipment, and materials to install guardrail, guardrail transitions, guardrail terminals, and end anchors, constructed new, reconstructed, or constructed guardrail from salvage in accordance with the locations and details shown on the plans and the requirements of these specifications, including all necessary components and delineation.

905-2 Materials:

Materials for guardrail, guardrail transitions, and end anchors shall conform to the requirements of Section 1012 of the specifications and the plans.

Materials for guardrail terminals shall conform to the requirements of the approved manufacturer's drawings and specifications. Only those guardrail terminals referenced in the plans will be allowed.

Flexible guardrail markers shall be made of a high quality, impact- and ultraviolet-resistant, flexible, white-colored plastic or similar material with a minimum thickness of 0.075 inch. This material shall be configured into a rectangular body that is flat, curvilinear or tubular with a width of between 3 and 4 inches. The minimum reflective area for L-shaped and T-shaped markers, attached to the top of wooden posts, and U-shaped markers, attached to the top of steel I-beam posts, shall be 10 square inches. The reflectorized surface for flexible vertical guardrail markers attached to the approach side of posts shall be 3 inches wide by 5 inches long.

Adhesive materials for applying reflective sheeting to guardrail terminals and flexible guardrail markers shall be in accordance with the sheeting manufacturer's recommendations.

Guardrail delineator material shall be specifically manufactured to provide roadside delineation. All delineators shall consist of complete units that are precut, pre-drilled as applicable, and ready to be installed in the field. The delineators shall be packaged in such manner as to prevent damage and deterioration during shipping and storage.

Reflective sheeting for object markers on guardrail terminals, and reflective sheeting used for all other guardrail markers, including flexible guardrail markers, shall conform to the requirements of Section 1007 of the specifications.

Transparent colors, inks and paints used in fabrication shall be of the type and quality recommended by the sheeting manufacturer. Transparent colors shall be applied with screen mesh P.E. 157 using fill pass.

Approved guardrail terminals, flexible guardrail markers, and reflective sheeting products are shown on the Department's Approved Products List (APL). Copies of the most current version of the APL are available on the internet from the Arizona Department of Transportation Research Center, through its Product Evaluation program.

905-3 Construction Requirements:

905-3.01 General:

The construction of the various types of guardrail, guardrail transitions, guardrail terminals, and end anchors shall include the assembly and erection of all component parts complete at the locations shown on the project plans or as directed by the Engineer. All materials shall be new except as provided for under Subsections 905-3.04 and 905-3.05 of the specifications.

The various types of guardrail shall be constructed with wood or composite blockouts on either wood or steel posts, at the option of the contractor, except where the post materials to be used are specified on the plans. Excluding guardrail transitions, terminals, long span, box culvert posts, and end anchors, the same type of post shall be used in any one continuous length of guardrail.

All metalwork shall be fabricated in the shop. No punching, drilling, cutting or welding shall be done in the field, except as provided for under Subsections 905-3.04, 905-3.05, and 905-3.06 of the specifications.

Where field cutting or boring of wood posts and blockouts is permitted, the affected areas shall be treated in accordance with the AWPA Standard M4.

Where wood posts with rectangular sections are used, the posts shall be set so that the longest dimension is perpendicular to the rail.

All bolts shall extend beyond the nuts a minimum of two threads, except that all bolts on posts adjacent to pedestrian traffic shall be cut off 1/4 inch from the nut.

All bolts shall be securely tightened unless torque requirements are specified on the plans or manufacturer's drawings.

Guardrail elements shall be spliced by lapping in the direction of traffic in the nearest adjacent lane.

Rail height of guardrail, transitions, terminals, long span, box culvert posts, and end anchors shall be within ±1 inch of the control height shown on project plans.

When guardrail is being constructed, or reconstructed under traffic, the contractor shall conduct its operations so as to constitute the least hazard to the public and construction personnel. Traffic control shall be provided in accordance with the requirements of Section 701 of the specifications.

905-3.02 Roadway Guardrail:

Guardrail posts shall be set to the line, grade, and spacing shown on the plans. Earthwork placement, grading, compacting, and bituminous surfacing shall be completed prior to installation of the guardrail posts.

Wood posts shall be placed in pre-punched or pre-drilled pilot holes. Steel posts shall either be driven, or placed in manually or mechanically dug holes. New post holes, and existing post holes to be reused shall contain well compacted material under the post, and shall be backfilled with moist soils placed in compacted lifts as approved by the Engineer. Pre-punched post holes, or full depth post driving shall not be used at locations where damage to the curb, gutter, sidewalk, buried items, shoulders or pavement might occur. The Engineer will be the sole judge as to whether driving of posts will be allowed.

Driving of posts shall be accomplished in a manner which will prevent battering, burring, separation of the galvanizing from the steel or distortion of the post. Any post which is bent or otherwise damaged to the extent it is unfit for use in the unfinished work, as determined by the Engineer, shall be removed and replaced at no additional cost to the Department.

Where curb, gutter, sidewalk, buried items, shoulders, or pavement are disturbed in the construction of guardrail, the damage shall be repaired as approved by the Engineer.

Where the top surface of a culvert or other utility is at an elevation which would interfere with full depth post placement, the post shall be eliminated and long span guardrail shall be placed in accordance with the requirements of Subsection 905-3.09 of the specifications . Where the top surface of a box culvert is at an elevation which would interfere with full depth post placement, and long span guardrail cannot be used, the post shall be placed and anchored in accordance with the requirements of Subsection 905-3.06 of the specifications.

Where rock prevents the full depth placement of posts, the rock, post, and backfill shall be treated in accordance with Standard Drawings.

Wood blockouts shall be toe-nailed to the wood posts with one 16-penny galvanized nail on each side of the top of the blockout. Blockouts shall be set so that the top of the blockout is no more than 1/2 inch above or below the top of the post, unless otherwise shown on the project plans.

Rail elements shall be spliced at 25-foot intervals or less. Rail elements shall be spliced halfway between adjacent posts unless otherwise shown on the project plans. When the radius of curvature is 150 feet or less, the rail elements shall be shop curved.

905-3.03 Guardrail End Anchors:

End anchors shall be installed in accordance with the plans. Foundation tubes shall be supplied as part of the end anchor. Foundation tubes shall be driven with an approved driving head, or placed in manually or mechanically dug holes. The tubes shall not be driven with the wood post in place. When foundation tubes are placed in holes, the space around and under the tubes shall be backfilled with moist soils placed in compacted lifts, as approved by the Engineer. The foundation tube shall not protrude more than 4 inches above the ground as measured along a 5-foot chord.

905-3.04 Construct Guardrail from Salvage:

Salvaged guardrail, guardrail transitions, end anchors, and other guardrail systems shall be constructed at the locations shown on the project plans and in accordance with the provisions specified herein for new construction.

If any salvaged materials are deemed by the Engineer, to be unsuitable for reuse or if the quantities of salvaged materials are insufficient to complete the work, the contractor shall furnish new materials in sufficient quantities to complete the work and the cost of furnishing such materials will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

Salvage foundation tubes for end anchors shall not be reused.

Where new bolt holes in rail elements are permitted and approved by the Engineer, the holes shall be made by drilling or punching. Flame-cut bolt holes will not be permitted. All metal cut in the field shall be cleaned and painted with two coats of zinc paint in accordance with Section 1002 of the specifications.

905-3.05 Reconstruct Guardrail:

(A) General:

Existing guardrail, guardrail transitions, guardrail terminals, end anchors, and other guardrail systems shall be reconstructed at the locations shown on the project plans, and in accordance with the provisions specified herein for new construction.

Guardrail shall be reconstructed in accordance with either Subsection 905-3.05(B) or 905-3.05(C) of the specifications.

For reconstructed guardrail transitions, guardrail terminals, end anchors, and other guardrail systems, all components shall be completely removed and then reconstructed in place using existing posts, blockouts, and hardware, unless otherwise specified herein.

Reconstructed end anchors shall be installed with new foundation tubes.

Unless otherwise specified herein, where existing posts include a concrete foundation, the concrete foundation shall be fully removed and the hole backfilled with moist soil in compacted lifts, as approved by the Engineer. No separate payment will be made for removal of concrete foundations, or the subsequent backfill and compaction, the cost being considered as included in the contract item.

All guardrail components to be re-used shall be removed in such a manner as to prevent damage to and minimize the loss of the components.

Where new bolt holes in reused rail elements are permitted and approved by the Engineer, the holes shall be made by drilling or punching. Flame-cut bolt holes will not be permitted. All metal cut in the field shall be cleaned and painted with two coats of zinc paint in accordance with Section 1002 of the specifications.

Items designated to be reused which are lost, damaged or destroyed as a result of the contractor's operations shall be repaired or replaced by the contractor at no additional cost to the Department.

If any materials designated for reconstruction are deemed by the Engineer to be unsuitable for reuse or if the quantities of existing materials are insufficient to complete the work, the contractor shall furnish new materials in sufficient quantities to complete the work and

the cost of furnishing such materials will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

Existing posts, blockouts, rail elements, or hardware which are not required for guardrail reconstruction or which the Engineer deems unsuitable for reconstruction, shall be removed and disposed of as directed by the Engineer.

(B) Reconstruct Guardrail with Existing Materials:

When reconstruct guardrail with existing materials is specified, all guardrail components shall be completely removed and then reconstructed in place using existing rail elements, posts, blockouts, and hardware for posts and blockouts.

(C) Reconstruct Guardrail with New Posts, Blockouts, and Hardware:

When reconstruct guardrail with new posts, blockouts and hardware is specified, all guardrail components shall be completely removed and then reconstructed in place using existing rail elements, and new posts, blockouts, and hardware for posts and blockouts.

905-3.06 Box Culvert Guardrail Posts:

Box culvert guardrail posts for low fill culverts shall be constructed in accordance with plans.

Where field-cutting of steel posts is required, the affected areas shall be cleaned and painted with two coats of zinc paint in accordance with Section 1002 of the specifications.

905-3.07 Blank:

905-3.08 Guardrail Transitions:

Guardrail transitions to concrete barriers shall be constructed in accordance with the plans.

905-3.09 Long Span Guardrail:

This work shall consist of furnishing and constructing long span guardrail, including all materials, in accordance with the requirements of the project plans.

905-3.10 Guardrail Terminals:

Guardrail terminals shall be installed in accordance with the manufacturer's specifications and approved drawings. Prior to starting work, the contractor shall submit the current version of the

manufacturer's approved drawings and installation manuals for each type of guardrail terminal to be installed on the project. In case of discrepancy or conflict, the current manufacturer's specifications and approved drawings shall govern. Manufacturer's dimensions relative to the finished surface shall be measured along a 5-foot chord.

Earthwork placement, grading, compacting, and pavement surfacing shall be completed prior to installation of posts for guardrail terminals. The contractor shall install the posts in a manner that prevents heaving or other damage to the surface material. If the Engineer determines that heaving or other damage has occurred, the contractor shall remove and replace surface material at no additional cost to the Department.

905-3.11 Guardrail Delineation:

(A) General:

Flexible guardrail markers shall be either L-shaped, U-shaped (for steel I-beam posts), or T-shaped delineators, or flexible vertical delineators. Flexible L-shaped, U-shaped, and T-shaped delineators shall be installed on the top of the posts, and shall be placed as close as possible to the roadway edge of the post with the retroreflective surface facing oncoming traffic of the nearest traveled lane. Flexible vertical delineators shall be installed on the side of the post facing oncoming traffic, level and true, with the retroreflective sheeting 38 inches above the roadway surface.

When nails are used to secure delineation to the top of wood posts, a minimum of two nails shall be driven at an angle to prevent the post from splitting. Side-mounted flexible vertical delineators shall be secured to wood posts with two 1/8-inch diameter by 2-inch long galvanized lag screws and flat washers. Side mounted delineation shall be secured to metal posts by drilling two holes through the post and attaching with two galvanized 1/8-inch diameter by 3/4-inch long bolts, flat washers, and lock nuts. Self-tapping 1/8-inch screws may be used as permitted by the Engineer.

The color of the retroreflective portion of the barrier markers and flexible delineators shall conform to the color of the adjacent edge line. Field application of retroreflective sheeting will not be allowed. The manufacturer shall apply all sheeting in the factory.

The contractor shall remove and replace damaged delineation at no additional cost to the Department.

(B) Guardrail Delineation:

Flexible guardrail markers shall be installed at every sixth post. On radial sections of guardrail, the flexible guardrail markers shall be placed at every other post.

(C) Guardrail Terminal Delineation:

Delineation for guardrail terminals shall be compatible with the average project elevation and traffic direction shown on the plans. The contractor shall maintain consistency within the project limits by selecting the same type of delineation for all similar installations.

For guardrail terminals, the contractor shall use L-shaped, T-shaped, or U-shaped markers, or flexible vertical delineators on the posts shown in Standard Drawings.

The configuration of reflective sheeting object markers on the approach and departure faces of the guardrail terminal.

905-4 Method of Measurement:

The limits of measurement for the various guardrail items are shown on the plans.

Guardrail, of the type shown on the project plans, will be measured by the linear foot along the face of the rail element from center to center of splices, exclusive of guardrail terminals, end anchors, and guardrail transitions. Lengths of tapers required for connecting to existing guardrail and the long span guardrail will be included in overall guardrail length.

Guardrail terminals will be measured by the unit each, including all components and delineation required for a complete installation as shown on the plans and in the approved manufacturer's drawing and installation manual.

Guardrail end anchors will be measured by the unit each, including delineation and all other components required for a complete installation as shown on the plans.

Guardrail transitions will be measured by the unit each, including delineation and all other components required for a complete installation as shown on the plans.

Box culvert guardrail posts will be measured by the unit for each post anchored as shown on the plans. One unit will consist of the cut and fitted guardrail post, anchor plate, and hardware.

Constructing the various types of guardrail, guardrail transitions, and end anchors from salvage will be measured by the linear foot, or by the unit each, using the limits of measurement specified for new construction.

Reconstructing the various types of guardrail, guardrail transitions, guardrail terminals, and end anchors will be measured by the linear foot,

or by the unit each, using the limits of measurement specified for new construction.

905-5 Basis of Payment:

The accepted quantities of guardrail, measured as provided above, will be paid for at the contract unit price per linear foot for the types of guardrail installation designated in the bidding schedule, complete in place, including all guardrail delineation, excavation, backfill and disposal of surplus material.

The accepted quantities of guardrail terminals, measured as provided above, will be paid for at the contract unit price each, complete in place, including all components and delineation as required, excavation, backfill and disposal of surplus material.

The accepted quantities of guardrail end anchors, measured as provided above, will be paid for at the contract unit price each, complete in place, including all guardrail components and delineation as required, excavation, backfill, disposal of surplus material, and installation of foundation tubes.

The accepted quantities of guardrail transitions to concrete barriers, measured as provided above, will be paid for at the contract unit price each, complete in place, including guardrail posts, blockouts, hardware, terminal connection, excavation, backfill and disposal of surplus material. Concrete barrier that is constructed with a guardrail transition shall be measured and paid for in accordance with the requirements of Section 910 of the specifications for concrete barrier transition.

Payment for furnishing and placing earthwork and surfacing material for pavement widening associated with new guardrail and at the flares of guardrail terminals will be measured and paid for under the respective contract items.

The accepted quantities of box culvert guardrail posts, measured as provided above, will be paid for at the contract unit price each, and shall be full compensation for the work, complete in place, including anchor plates, hardware, excavation, backfill, removing and replacing surfacing, cutting and fitting steel beam posts, drilling anchor bolt holes in steel posts and box culverts, and disposal of surplus materials.

The accepted quantities of construct guardrail, guardrail transitions, and end anchors from salvage, measured as provided above, will be paid for at the contract unit price, complete in place, including all new guardrail delineation, removal of existing delineation as necessary, excavation, backfill and disposal of surplus or unusable materials.

The accepted quantities of reconstruct guardrail with existing materials, measured as provided above, will be paid for at the contract unit price, complete in place, including all new guardrail delineation, removal of

existing delineation as necessary, excavation, backfill and compaction, and disposal of surplus or unusable materials.

The accepted quantities of reconstruct guardrail with new posts, blockouts, and hardware, measured as provided above, will be paid for at the contract unit price, complete in place, including all new posts, blockouts, and hardware, new guardrail delineation, removal of existing delineation as necessary, excavation, backfill and compaction, and disposal of surplus or unusable materials.

The accepted quantities of reconstruct guardrail transitions, guardrail terminals, and end anchors, measured as provided above, will be paid for at the contract unit price, complete in place, including new guardrail delineation, removal of existing delineation as necessary, excavation, backfill and compaction, and disposal of surplus or unusable materials. Payment for reconstructing end anchors will include all costs for providing and installing new foundation tubes.

The contractor will be paid in accordance with the provisions of Subsection 109.04 of the specifications for furnishing new posts, blockouts, rail elements or hardware to replace components deemed by the Engineer unsuitable for reuse, or to supplement insufficient existing quantities for reconstructing the various types of guardrail, or for constructing the various types of guardrail from salvage.

Reconstruct guardrail does not include stockpiling or relocating guardrail. Guardrail requiring stockpiling or relocating will be compensated under two separate bid items:

(A) Remove and Salvage Guardrail; and

(B) Construct Guardrail from Salvage.

SECTION 906 CATTLE GUARDS:

906-1 Description:

The work under this section shall consist of furnishing all materials and constructing new cattle guards or reconstructing existing cattle guards at the locations shown on the project plans or designated by the Engineer, in accordance with the details shown on the plans and the requirements of these specifications.

906-2 Materials:

906-2.01 Concrete:

Concrete shall conform to the requirements of Section 1006 of the specifications for Class B concrete.

906-2.02 Steel:

Reinforcing bars and structural steel shall conform to the requirements of Section 1003 and Section 1004 of the specifications, respectively. ASTM A570, Grade 40 steel may be used as an alternate to ASTM A36 for the fabrication of cattle guard grill rails.

906-2.03 Fencing:

Fence posts and braces shall conform to the requirements of Sections 902 and 903 of the specifications.

906-2.04 Backfill:

Backfill material shall conform to the requirements of Subsection 203-5 of the specifications.

906-2.05 Wood:

Wooden shims shall conform to the requirements shown on the plans.

906-3 Construction Requirements:

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of the specifications.

Completed cattle guards shall be well drained.

Cattle guards shall be cast-in-place or, at the option of the contractor, may be precast units. A list of approved precast units may be found on the Department's Approved Products List (APL), available on the internet from the Arizona Transportation Research Center (ATRC), through its Product Evaluation Program. The use of precast cattle guards shall be limited to roadway locations with maximum longitudinal grades of 6 percent. Precast units shall be installed to match the roadway centerline profile grade and the roadway cross-slope.

Cattle guards shall be constructed in accordance with the details shown on the plans in reasonably close conformity to the lines and grades established or shown on the project plans. All fence and steel gates required shall be constructed as specified under Section 902 or 903 of the specifications, as applicable.

Painting of structural steel shall be in accordance with the requirements of Section 610 of the specifications. Structural steel shall be painted with one coat of primer (Paint No. 1) in accordance with Section 1002 of the specifications. Painting of fence posts and gates shall be in accordance with the requirements of Section 902 or 903 of the specifications, as applicable.

Existing cattle guards designated on the project plans for reconstruction shall be dismantled to the extent required and in such a manner as to preserve all materials or portions of the existing structure that are acceptable for use in the reconstructed structure. All removed concrete shall be disposed of in accordance with the requirements of Subsection 202-3.03(A) of the specifications.

Cattle guards to be reconstructed shall be constructed as specified herein, except that the materials required shall be salvaged to the extent possible from the existing cattle guards designated on the plans to be reconstructed or removed.

Steel angles providing a bearing surface for each grille unit of a roadway cattle guard and wooden shims under railroad cattle guards shall be set to the required elevations with sufficient accuracy that no rocking under load of a grille unit or tread assembly can be observed and that no gap greater than 1/32 inch exists between any pair of bearing surfaces when the unit or assembly is not under load and is not spiked, welded or otherwise held in place.

The fabrication and connections of grille units, angle units, and other steel elements shall conform to the requirements of Section 604. Either H-10 or H-20 loading will be designated on the project plans.

906-4 Method of Measurement:

Cattle guard, and reconstruct cattle guard will be measured as a unit for each structure.

Cattle guards consisting of a different number of grille units, different "H" loadings, different widths, or being new instead of reconstructed will be measured separately.

906-5 Basis of Payment:

The accepted quantities of cattle guards and reconstruct cattle guards, measured as provided above, will be paid for at the contract unit price each, complete in place, including excavation, structure backfill, structural steel, reinforcing steel, grilles, concrete, painting, wood shims and concrete slabs where required.

Payment for fence or gates will be made as specified under Section 902 or 903 of the specifications, except that posts and braces attached to the cattle guard shall be considered as included in the cost of the cattle guard.

SECTION 907 DAMPPROOFING AND WATERPROOFING CONCRETE SURFACES:

907-1 Description:

The work under this section shall consist of furnishing all materials and dampproofing concrete surfaces or waterproofing concrete structures and joints at the locations shown on the project plans and in accordance with the requirements of the plans and these specifications.

907-2 Materials:

907-2.01 General Requirements:

The materials furnished by the contractor to dampproof or waterproof concrete structures as shown on the plans shall conform to the requirements of this section unless otherwise specified on the project plans or in the Special Provisions. Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

All materials shall be delivered in the original packages bearing the manufacturer's brand and label. The manufacturer's label and/or the Certificate of Compliance shall state that the fabric has been saturated with asphalt. Fabrics saturated with coal-tar pitch are not acceptable. Materials shall be delivered on the work site a sufficient time before they are to be used to permit testing and analyzing, if required by the Engineer. The fabric shall be stored in a dry place, and the rolls shall not be stored on end.

907-2.02 Prime Coats:

An asphalt primer conforming to the requirements of ASTM D41 shall be used.

907-2.03 Mop Coats:

An asphalt which conforms to the requirements of ASTM D449 Type III, shall be used for the mop coats.

907-2.04 Fabric:

The fabric shall be bituminized cotton fabric conforming to the requirements of ASTM D173. The fabric shall be saturated with asphalt.

907-3 Construction Requirements:

907-3.01 General:

Bituminous coats shall not be applied in wet weather nor when the ambient temperature is below 50 degrees F. Concrete shall be dry and clean before the prime coat is applied. If bituminous material is used for curing, it may also serve as a priming coat, except that additional primer may be necessary before application of the mop coat. The material for mop coats shall be heated as necessary to aid application, but not above 350 degrees F.

The bitumen shall be heated in kettles equipped with armored thermometers, and stirred frequently.

Primer shall be allowed to cure properly before applying the mop coat. The primer shall be applied without heating at the approximate rate of 1 gallon per 100 square feet of surface with a three- or four-knot roofing brush. If asphalt primer is too thick to allow easy brushing, the material may be thinned by the addition of a small quantity of gasoline or naphtha.

Work shall be so regulated that at the end of the day all fabric that has been applied will have received a mop coat.

Concrete surfaces not to be dampproofed or waterproofed shall be protected from the spilling or otherwise marring of the surface with the bituminous materials.

907-3.02 Dampproofing:

Concrete surfaces to be dampproofed shall be given an asphalt primer and an asphalt mop coat.

Each coat shall be applied uniformly, fully covering the surface, and shall be thoroughly worked into the surface.

After the primer has cured, the mop coat shall be applied at the rate of approximately 50 pounds per 100 square feet of surface to obtain a thickness of approximately 5/64 inch for the dampproof coating.

Within the areas to be treated, all expansion or construction joints that are not protected with metal seals and which will be covered with earth in the completed structure shall be protected with a single layer or strip of bituminized cotton fabric not less than 12 inches wide. The fabric shall be laid evenly over the joints and in a fresh mopping of asphalt. The fabric shall be pressed into place and shall be smooth and free of creases. Joints in the fabric shall lap 12 inches. After placing, the fabric shall be sealed with a mop coat.

Sections dampproofed shall be protected against mechanical injury and high temperature as soon as possible after application and until final acceptance of the work.

907-3.03 Membrane Waterproofing:

(A) Surface Preparation:

Waterproofing may be used in conjunction with slab protection, sheet metal seals or other protective devices.

Surfaces of concrete to be waterproofed shall be smooth and free from projections which might injure the waterproofing membrane. The surfaces shall be cleaned of dust, dirt, grease and loose particles or any foreign substances and shall be dry prior to placing waterproofing.

The use of compressed air may be required in order to remove dust and loose dirt from corners and joints. Damp surfaces may be dried by covering with a layer of hot sand. The sand shall remain in place one or two hours, after which it shall be removed from enough surface to allow the work to proceed.

After the surfaces of concrete to be waterproofed have been thoroughly cleaned and prior to the first hot mop coat, one coat of primer shall be applied. The primer shall be thoroughly worked into the concrete to give a uniform coating.

(B) Application of Membrane:

Two- or three-ply membrane waterproofing, as specified on the project plans, shall be applied after the primer has cured.

Two-ply membrane waterproofing for the protection of footing construction joints or other designated areas shall consist of two layers of bituminized cotton fabric and three mop coats, placed alternately over the concrete surface previously treated with one coat of primer.

Three-ply membrane waterproofing for the protection of decks and sides of structures or other designated areas shall consist of three layers of bituminized cotton fabric and four mop coats, placed alternately over the concrete surface previously treated with one coat of primer.

The layers of the treated cotton fabric shall be laid so that all edges will lap at least 2 inches. The line of lap shall in every case be broken with that of the preceding layer of membrane. Each strip shall be laid in a fresh hot mop coat and when the specified number of layers has been laid, the entire surface shall be mopped. If practicable, the laying of the fabric shall begin at the lowest part of the surface to be waterproofed. The surface shall be completely covered with a heavy mop coat before the strip of fabric is put down. The mopping shall be so done that there will be no air bubbles, pockets or spots where the surface shows

through. As soon as a strip of fabric has been laid, it shall be pressed into the coat to eliminate air bubbles. Creases in the fabric shall be smoothed out carefully by pulling the fabric. The top mopping shall be of such thickness and be so applied as to seal and cover the fabric completely.

Waterproofing shall be free from punctures, pockets or folds.

Special care shall be taken so that the fabric is completely sealed down at the laps. The waterproofing membrane shall be continuous and unbroken.

At joints in the membrane, the laps shall be at least 12 inches. The fabric for making the lap shall be left unmopped until the joint is completed.

On horizontal surfaces, not less than 4 gallons in each mop coat shall be used for each 100 square feet of surface, and on vertical surfaces, not less than 5 gallons in each mop coat shall be used for each 100 square feet of surface.

Expansion and contraction joints shall be covered with membrane waterproofing as required by the plans.

Sections waterproofed shall be protected against mechanical injury, high temperature and chemical action, as soon as possible after application and until final acceptance of the work.

907-4 Method of Measurement:

The project plans will show the estimated quantity of surface area to be dampproofed and/or waterproofed and the contractor shall assure itself that this estimated quantity is substantially correct.

907-5 Basis of Payment:

No direct payment will be made for Dampproofing and Waterproofing Concrete Surfaces. The cost of furnishing and applying all materials shall be considered as included in the contract price paid for concrete of the class treated.

SECTION 908 CONCRETE CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS:

908-1 Description:

The work under this section shall consist of furnishing all materials and constructing Portland cement concrete curb, curb and gutter, ramp curb, sidewalk, sidewalk ramps, driveways, and valley gutters at the locations

shown on the project plans in accordance with the details shown on the plans and the requirements of these specifications.

908-2 Materials:

908-2.01 Concrete:

Concrete shall be Class B concrete conforming to the requirements of Section 1006 of the specifications.

908-2.02 Expansion Joint Filler:

Expansion joint filler shall be 1/2-inch bituminous or nonbituminous preformed strips conforming to the requirements of Subsection 1011-6 of the specifications.

908-2.03 Concrete Curing Compound:

Curing compound shall be liquid membrane-forming compound conforming to the requirements of Subsection 1006-6.01(C) of the specifications.

908-2.04 Detectable Warning Strip:

Detectable warning strips shall consist of a pre-fabricated mat with truncated domes aligned in a square grid matrix on a flat substrate, or other pre-fabricated materials meeting the requirements of the Standard Drawings. Detectable warning strips shall contrast visually with the sidewalk ramp, and shall conform to the current requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG). Detectable warning strips shall be pre-fabricated from durable material approved by the Department. All detectable warning strips installed within the project limits shall be the same type, unless shown otherwise on plans or approved by the Engineer.

Pre-fabricated detectable warning strips approved for use are shown on the Department's Approved Products List (APL). The most current version of the APL is available on the internet from the ADOT Research Center, through the Product Evaluation Program. Pre-fabricated detectible warning strips not listed on the APL may be considered for use in accordance with the requirements of Subsection 106.14 of the specifications.

908-3 Construction Requirements:

The subgrade shall be constructed in reasonably close conformity to the lines and grades established or shown on the project plans.

Prior to placing concrete curb, curb and gutter, driveway, valley gutter, sidewalk ramp, or sidewalk, the material on which they are to be placed

shall be compacted to a depth of at least 6 inches to a density of not less than 95 percent of the maximum density determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual as directed and approved by the Engineer.

All soft or unsuitable material shall be removed to a depth of not less than 6 inches below subgrade and replaced with material approved by the Engineer.

Single curb, curb and gutter, and sidewalk shall be constructed either by the use of conventional fixed forms or by slip-form curb and sidewalk placing machines.

Weather and temperature limitations for the placement of concrete shall be in accordance with the requirements of Subsection 1006-5 of the specifications.

Forms shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity and smoothness of surface. The depth of face forms for concrete curbs shall be equal to the full face height of the curb.

All other forms shall be set to form the full depth of all edges not formed by adjacent concrete. Unsatisfactory forms shall not be used.

Forms shall be set in reasonably close conformity to the dimensions, lines and grades shown on the project plans or established by the Engineer and be securely staked in position. Clamps, spreaders, and braces shall be used where required to ensure rigid forms.

When the roadway section slopes away from the gutter, the slope of the gutter shall be formed to match the roadway cross slope.

The subgrade and forms shall be watered immediately before placing concrete. Concrete shall be placed in the forms and thoroughly consolidated. The concrete shall be consolidated by means of approved mechanical vibrators or by tamping or spading by hand. The fresh concrete shall be struck off so the surface will be at the proper elevation when the concrete is consolidated. Concrete shall be thoroughly worked so that the coarse aggregate is below the surface. The surface shall then be finished to grade and cross-section with a float, troweled smooth and then given a final fine brush finish.

The exposed edges shall be tooled to a 1/4-inch radius unless a larger radius is indicated on the plans. When concrete placed in curb has set sufficiently so that it will not slump, the front face form shall be removed. The gutter, front face, and top of curb shall be troweled smooth and then given a final fine brush finish with brush strokes parallel to the lines of curb and gutter. The exposed edges shall be tooled to a 1/4-inch radius.

Expansion joints shall be constructed at tangent points of curb returns, at structures, and at a maximum of 60-foot intervals. Expansion joints shall be constructed between sidewalks and driveways, between sidewalks and abutting structures, around poles, posts, boxes, and other fixtures that protrude through the sidewalk. Expansion joints shall match as nearly as possible to the joints in the adjacent pavement or existing concrete curb and sidewalk. Joint filler shall be placed vertically and extend full depth beginning 3/16 inch below the surface of the concrete being placed. During the placing and tamping of concrete, the filler shall be restrained in its proper position.

Edges of the concrete at expansion joints shall be tooled to a 1/4-inch radius.

Contraction joints (weakened-plane joints) shall be constructed at a maximum of 15-foot intervals in curb and gutter and sidewalks and shall coincide with contraction joints in adjacent pavement or existing concrete curb and sidewalk. A contraction joint shall be constructed along the center of driveway entrances 20 feet wide or greater.

Longitudinal contraction joints shall be constructed in the center of sidewalk having a width greater than 7 feet. Contraction joints shall either be formed or sawed. Formed contraction joints shall be constructed by parting the large aggregates in the fresh concrete with a straightedge to a depth of 2 inches. The final joint finishing shall be accomplished with a jointer tool having a radius of 1/4 inch leaving a finished joint depth of a minimum of 3/4 inch. Sawed joints shall be sawed to a depth of 2 inches or one-third the thickness of the concrete, whichever is greater.

Scoring lines, where required, shall have a minimum depth of 1/4 inch and a radius of 1/8 inch. Where longitudinal scoring lines are required, they shall be parallel to, or concentric with, the lines of the work.

Forms shall be thoroughly cleaned each time they are used and shall be coated with a light oil as required to prevent the concrete from adhering to them.

If slip-form equipment is used to construct curb and gutter and sidewalk, such equipment shall be designed specifically for the work. The results shall be equal to or better than that produced by the use of fixed forms. If the results are not satisfactory to the Engineer, the use of the equipment shall be discontinued. All applicable requirements of construction by use of fixed forms shall apply to the use of slip-form equipment.

The slip-form equipment shall be controlled as to line and grade by means of automatic sensing and control devices such that the machine automatically senses and follows either a taut guide line or other reference, performing any necessary corrective maneuvers in order to establish the correct grade and alignment. The contractor shall set the guide line from survey marks.

Immediately following the required finishing operations, one or more applications of curing compound shall be applied to all exposed surfaces.

The curing compound shall be applied at the rate of not less than 1 gallon per 150 square feet of surface area, and in such manner as to entirely cover and seal all exposed surfaces of concrete with a uniform film.

The surface of concrete sidewalk shall be tested with a 10-foot straightedge. Any deviation in excess of 1/4 inch shall be corrected at no additional expense to the Department.

The face, top, back, and flow line of the curb and gutter shall be tested with a 10-foot straightedge or curve template, longitudinally along the surface.

Any deviation in excess of 1/4 inch shall be corrected at no additional expense to the Department.

No vehicular traffic will be allowed on driveways until the concrete has reached at least 60 percent of the required 28-day strength.

Before acceptance of the work, all curb and gutter and sidewalk shall be cleaned of all discolorations resulting from the contractor's operations, including, but not limited to, dirt, stains, bitumens, and equipment tire marks. Cleaning may be by abrasive blast methods or by other methods approved by the Engineer.

The top surface of detectable warning strips, exclusive of the truncated domes, shall be within ± 1/16 inch of the sidewalk ramp surface in accordance with the requirements of the ADAAG. Detectable warning strips shall be installed in accordance with manufacturer’s instructions and current industry practice. In case of discrepancy the manufacturer’s instructions shall govern.

908-4 Method of Measurement:

Concrete single curb and curb and gutter will be measured by the linear foot along the flow line. Lengths of depressed curb and depressed curb and gutter at driveway and sidewalk ramp locations will be included in the measurement. Lengths of curb transition and terminal, and curb and gutter transition and terminal will be included in the measurement. Lengths occupied by catch basins will be excluded from the measurement. No measurement will be made for ramp curb.

Concrete sidewalks, driveways, and valley gutter will be measured by the square foot of area constructed. Areas occupied by catch basins will be excluded from the measurement.

Concrete sidewalk ramps, of the type shown on the plans, will be measured either as a unit for each or by square foot, as listed in the bidding schedule, of sidewalk ramp constructed, including detectable warning strip.

908-5 Basis of Payment:

The accepted quantities of concrete single curb, curb and gutter, valley gutter, sidewalk, and driveway, measured as provided above, will be paid for at the contract unit price per linear foot or square foot, which price shall be full compensation for the work, complete in place, including furnishing and placing embankment material, excavating, removing unstable material, backfilling and compacting.

The accepted quantities of sidewalk ramps, measured as provided above, will be paid for at the contract unit price each, or per square foot, which price shall be full compensation for the work, complete in place, including furnishing and placing embankment material, excavating, removing unsuitable material, backfilling and compacting, surface finishing, and furnishing and installing the detectable warning strip.

No separate measurement or payment will be made for the ramp curb along the back edge or side of sidewalk ramps, nor for the detectable warning strip, the costs being considered as included in the price of contract items. No separate payment will be made for the curb along the back edge of sidewalk connecting sidewalk ramps at an intersection, the cost being considered as included in the price of contract items.

SECTION 909 SURVEY MONUMENTS:

909-1 Description:

The work under this section shall consist of furnishing all materials and installing concrete monuments, including cast iron frames and covers; furnishing cast iron frames and covers; or removing and resetting existing frames and covers at the locations shown on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

909-2 Materials:

909-2.01 Concrete:

Concrete shall be utility concrete conforming to the requirements of Section 922 of the specifications. The standard marker cap will be furnished by the Department. Section line marker caps shall be furnished by the contractor, and shall be stamped in accordance with Manual of Surveying Instructions 1973, published by the Department of Interior, Bureau of Land Management. Survey monuments shall be magnetically detectable.

909-2.02 Frames and Covers:

Frames and covers shall conform to the requirements of Subsection 1004-6 of the specifications for gray iron castings. The bearing face of the frame shall be machined so that the cover will lie flat in any position in the ring and have a uniform bearing throughout its entire circumference. Before leaving the foundry, the frames and covers shall be thoroughly cleaned.

909-3 Construction Requirements:

909-3.01 Survey Monuments:

Excavation for new monuments shall be the depths designated on the plans. The monuments shall be backfilled with suitable material tamped into place to provide a stable and secure installation. The concrete base, cast iron frame, bituminous mix and cover shall then be placed as detailed on the plans. The frame and cover shall be installed in a manner similar to that required under Subsection 505-3.01 of the specifications.

909-3.02 Frames and Covers:

New frames and covers shall be installed as specified under Subsection 909-3.01 of the specifications.

909-3.03 Reset Frames and Covers:

Existing frames and covers to be reset shall be carefully removed and reset as specified under Subsection 909-3.01 of the specifications; however, at the contractor's option and with approval of the Engineer, adjustable extension rings conforming to the requirements of Subsection 505-3.03 of the specifications may be used. Frames and covers broken or damaged in removing and resetting shall be replaced at no additional cost to the Department.

909-4 Method of Measurement:

Survey monuments will be measured as a unit for each survey monument, including frame and cover; for each frame and cover; or for each existing frame and cover removed and reset.

909-5 Basis of Payment:

The accepted quantities of survey monuments, frame and cover for survey monument and reset frame and cover for survey monument, measured as provided above, will be paid for at the contract unit price each, complete in place, including excavating and backfilling.

SECTION 910 CONCRETE BARRIERS:

910-1 Description:

The work under this section shall consist of furnishing all materials and constructing Portland cement concrete barriers at the locations shown on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

910-2 Materials:

Unless otherwise shown on the plans, concrete shall be Class S Portland cement concrete conforming to the requirements of Section 1006 of the specifications with a compressive strength of at least 4,000 pounds per square inch at 28 days.

Reinforcing steel shall be in accordance with the requirements of Section 1003 of the specifications.

Dowels shall be corrosion resistant coated dowel bars conforming to the requirements of AASHTO M 254, Type A.

Grout for pressure grouting the joints of precast barriers shall conform to the requirements of Subsection 602-2.03 of the specifications.

Grout for the bedding of precast barriers shall conform to the requirements of Subsection 913-2.01(D) of the specifications.

Joint sealant shall be a latex sealing compound conforming to the requirements of ASTM C834, applied as recommended in ASTM C1193.

910-3 Construction Requirements:

910-3.01 General:

Unless otherwise required by the project plans or Special Provisions, concrete barrier shall be constructed by any of the following methods or combinations thereof, at the contractor's option:

(A) Cast-in-place by slip-form;
(B) Cast-in-place by fixed forms; and/or
(C) Precast

Concrete barriers shall have a smooth, uniform appearance in their final position, conforming to the horizontal and vertical lines shown on the project plans or as ordered by the Engineer.

When concrete barriers are to be constructed on recently completed bridges, the barriers shall be placed after falsework has been released

and as long after superstructure construction as the progress of the work will permit, unless otherwise ordered by the Engineer.

Concrete barriers and concrete barrier transitions which are constructed on bridge structures, approach slabs and anchor slabs shall be constructed by cast-in-place, fixed-form methods. Precast or slip-form methods will not be allowed.

When a concrete barrier is not placed on pavement, the supporting material shall be shaped and finished in reasonably close conformity to the lines, grades and dimensions established by the Engineer or shown on the project plans.

The material shall be compacted to at least 95 percent of the maximum density determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

All exposed surfaces shall be given a Class II finish and shall be in accordance with the requirements of Subsection 601-3.05 of the specifications. Curing of concrete shall be in accordance with the requirements of Subsection 1006-6 of the specifications.

Construction of barrier reinforcement shall conform to the requirements of Subsection 605-3 of the specifications.

Concrete placement shall not be conducted over live traffic.

Barrier markers shall be installed in accordance with the details shown on the plans.

910-3.02 Cast-In-Place by Slip Form:

(A) General:

Concrete barriers constructed by using a slip-form machine or similar equipment shall be of well compacted, dense concrete. At the option of the contractor, concrete may be made with materials continuously batched by volume and mixed in a continuous mixer in accordance with the requirements of ASTM C685, except that sampling, testing, and acceptance of the concrete will be in accordance with the requirements of Section 1006 of the specifications.

The contractor may be required to furnish evidence of successful operation of the slip-form machine or other related equipment prior to beginning work. Slip-forming equipment shall be controlled by guidelines or wireless controls set from survey marks shown on the project plans or established by the Engineer. The slip-forming equipment shall be readily adjustable to conform to the proposed grade lines and vertically during the forward motion of the machine to conform to the pre-determined grade line during operations. A grade line gauge or pointer

shall be attached to the machine in such a manner that a continual comparison can be made between the barrier being placed and the established grade line as indicated by the offset guide line.

In lieu of the above method for maintaining the barrier grade, the slip-form machine may be operated on rails, forms, or on an existing pavement.

Slip-form barrier will be considered to not require additional finishing if the surface meets the requirements of a Class II finish as described in Subsection 601-3.05 of the specifications and the alignment is satisfactory. If the barrier does not meet these requirements, operations shall be stopped until adjustments are made to the equipment or the concrete mix that will result in an acceptable product. Barriers that cannot be refinished to meet the specifications for a Class II finish shall be removed and replaced at the contractor's expense. Barriers that have unsatisfactory alignment and straightedge tolerance shall be penalized or replaced in accordance with these specifications.

Concrete shall be placed and consolidated by methods that do not cause harmful segregation. To produce the required consolidation, the equipment shall be operated under sufficient speed and uniform restraint to the forward motion.

The concrete shall be of such consistency that after slip-forming operations it will maintain the shape of the barrier without support. The contractor shall ensure the integrity and positioning of all barrier steel reinforcement and conduit throughout slip-forming operations, maintaining adequate clear cover and spacing requirements as shown in the project plans. At the contractor's option, additional barrier steel reinforcement may be added at no additional cost to the Department.

Unless otherwise specified in the Special Provisions, the contractor shall construct a confirmation section of concrete barrier to demonstrate to the Engineer successful slip-forming operations during concrete barrier placement. Confirmation sections of concrete barrier may be waived if approved by the Engineer in writing. The confirmation section shall be a minimum of 100 feet to 300 feet in length and constructed in accordance with the requirements of the contract documents. The confirmation section will be evaluated for conformance to the requirements of the contract documents by the Engineer. If the confirmation section is determined to be non-compliant, those sections of concrete barrier not in conformance, shall be removed and replaced at no additional cost to the department. In addition, a revised plan for placement of the concrete barrier shall be submitted to the Engineer for approval. A maximum of two confirmation sections may be constructed to demonstrate successful slip-forming operations. If the contractor fails to demonstrate compliance with the contract requirements after 2 completed confirmation sections, the Engineer may disallow use of the slip-form method.

If at any time during concrete barrier placement the Engineer determines the slip-forming operations to be non-compliant with the contract requirements, the contractor may be required to construct additional confirmation sections and/or revise the plan for placement of the concrete barrier in order to demonstrate to the Engineer conformity of slip-forming operations.

(B) Dimensional Tolerances:

(1) The top of exposed faces of the barrier shall comply with the following tolerances to be accepted at 100 percent of the unit price bid per linear foot.

(a) When a 10-foot long straightedge is placed on the top surface of the barrier, it shall not vary by more than 1/4 inch from the straightedge.

(b) When a 10-foot straightedge is placed along the face of the barrier, it shall not vary by more than 1/2 inch from the straightedge.

(c) The horizontal alignment shall not deviate by more than that allowed in Section 401 of the specifications when placed adjacent to Portland Cement Concrete Pavement.

All other barrier dimensions shall not deviate by more than 1/2 inch from plan alignment.

(2) The top and exposed faces of the barrier shall comply with the following tolerances to be accepted at 75 percent of the unit price bid per linear foot.

(a) When a 10-foot long straightedge is placed on the top surface of the barrier, it shall not vary by more than 1/2 inch from the straightedge.

(b) When a 10-foot long straightedge is placed along the face of the barrier, it shall not vary by more than 3/4 inch from the straightedge.

(c) The horizontal alignment shall not deviate by more than that allowed in Section 401 of the specifications when placed adjacent to Portland Cement Concrete Pavement.

All other barrier dimensions shall not deviate by more than 3/4 inch from plan alignment.

Those portions of the barrier not in compliance with the minimum requirements specified in this subsection shall be removed and replaced at no additional cost to the Department.

910-3.03 Cast-In-Place by Fixed Forms:

Concrete barrier cast-in-place with fixed forms shall be constructed and cured in accordance with the requirements of Section 601 of the specifications. If new or like new metal or wood forms are used and it is apparent, after the forms are stripped, that special care has been taken to produce uniformly textured surfaces with pleasing appearance, the Engineer may waive the specified additional finishing to produce a Class II finish.

The barrier shall be cast in sections of the length shown on the project plans and the edges of the joints between sections shall be rounded to a 1/4-inch radius.

After the concrete has cured for seven days, the joint shall be filled to a depth of at least 1 inch with joint sealant.

When a 10-foot long straightedge is placed on the top and along the faces of the barrier, the surface shall not vary more than 1/4 inch from the straightedge.

910-3.04 Precast:

Precast concrete barriers shall be cast in accordance with the requirements of Section 601 of the specifications.

After precast barrier has been approved for use on the project, no additional concrete finishing will be required. Should the finish of precast barrier be marred or damaged as a result of transporting or handling, the Engineer may reject it or allow refinishing. If refinishing is allowed, the resulting surface shall be of uniform texture and appearance and shall match the adjoining sections.

Each section of barrier shall be set on a layer of fresh and plastic grout at least 1 inch deep, so that grout is exuded for the full length on both sides of the base when the section is set to the true line and grade.

After adjacent sections of barrier have been doweled and set firmly in final position, the joint between them shall be filled with joint sealant to a depth of 1 inch, up both sides but not across the top. After the joint sealant has set firmly enough to withstand the grouting pressure, grout shall be forced into the pressure grout hole until it flows from the top of the joint.

When a 10-foot long straightedge is placed on the top and along the faces of the barrier, the surface shall not vary more than 1/4 inch from the straightedge.

910-4 Method of Measurement:

Concrete barrier will be measured by the linear foot along the center line of its top surface.

The measurement of the total length of the concrete barrier will not include any part which is within a length as shown on the project plans as a guardrail transition, as an impact attenuator, or as part of the structure of a bridge and extending between the stations of the ends of the bridge wing walls on the same side of the roadway. Sections of concrete barrier that transition from one shape, or type, to another shape, or type, and concrete barrier for guardrail transition, shall be measured by the unit each of concrete barrier transition that is not part of a structure.

910-5 Basis of Payment:

The accepted quantities of concrete barrier, measured as provided above, will be paid for at the contract unit price per linear foot, complete in place.

No measurement or direct payment will be made for any concrete barrier which is included as part of a bridge structure. Concrete barrier included as part of a bridge structure quantity will be paid for under the lump sum bridge item.

No measurement or direct payment will be made for barrier markers, the cost being considered as included in the cost of the concrete barrier, paid either by the linear foot or as part of a structure.

The accepted quantities of concrete barrier transition, measured as provided above, will be paid at the contract unit price per each, which price shall be full compensation for the work, complete in place, including excavation, backfill, caissons, structural concrete, reinforcing steel, anchors, anchor assemblies, and dowels. Guardrail attached to concrete barrier will be paid for in accordance with the requirements of Subsection 905-5 of the specifications.

SECTION 911 RIGHT-OF-WAY MARKERS:

911-1 Description:

The work under this section shall consist of furnishing all materials and installing new right-of-way markers, including reference markers, or removing and resetting existing right-of-way markers, at the locations shown on the project plans and the requirements of these specifications.

911-2 Materials:

911-2.01 Concrete:

Concrete shall be utility concrete conforming to the requirements of Section 922 of the specifications.

911-2.02 Steel:

Steel shall conform to the requirements of AASHTO M 183 for structural carbon steel.

911-2.03 Paint:

Paint shall be of the types specified on the plans and shall conform to the requirements of Section 1002 of the specifications.

911-3 Construction Requirements:

Right-of-way markers shall consist of a survey monument and a reference marker. The survey monument shall be cast-in-place concrete with a standard marker cap. The standard marker cap will be furnished by the Department.

Excavation for right-of-way markers shall be to the dimensions shown on the plans. Concrete shall be placed in accordance with the requirements of Section 922 of the specifications and the standard marker set in the fresh concrete.

The right-of-way markers and reference markers shall be set vertically in the ground. The reference markers shall be painted and lettered as shown on the plans.

Existing right-of-way markers, including reference markers, designated for removal and resetting shall be carefully removed and reset at the new locations in the manner specified herein for right-of-way markers. If required, the reset reference markers shall be painted as specified on the plans for new reference markers. Markers broken or damaged in removing and resetting shall be replaced at no additional cost to the Department.

911-4 Method of Measurement:

Right-of-way markers will be measured as a unit for each marker, including reference markers.

Reset right-of-way markers will be measured as a unit for each marker, including reference marker, removed and reset at the new location. Markers removed but not reset will not be included in the measurement.

911-5 Basis of Payment:

The accepted quantities of right-of-way markers and reset right-of-way markers, measured as provided above, will be paid for at the contract unit price each, complete in place.

SECTION 912 SHOTCRETE:

912-1 Description:

The work under this section shall consist of furnishing all materials and applying shotcrete on prepared surfaces at the locations and in accordance with the details shown on the plans and the requirements of the specifications.

Shotcrete shall be mortar or concrete conveyed through a hose and pneumatically applied using the wet mix process.

The wet mix process shall consist of premixing by mechanical methods a proportional combination of Portland cement, supplementary cementitious material, aggregate, and water required to produce mortar or concrete; conveying the mortar or concrete through the delivery hose to the special nozzle where additional compressed air is added at the nozzle prior to its discharge.

912-2 Materials and Equipment:

912-2.01 Portland Cement and Water:

Portland cement and mixing water shall conform to the requirements of Subsection 1006-2.01 and 1006-2.02 of the specifications, respectively.

912-2.02 Aggregate:

(A) Fine Aggregate:

Fine aggregate shall conform to the requirements of Subsection 1006-2.03(B) of the specifications.

(B) Coarse Aggregate:

Coarse aggregate shall conform to the requirements of Subsection 1006-2.03(C) of the specifications, except that it shall conform to the following gradation:

Sieve Size	Percent Passing
1/2 inch	100
3/8 inch	85 - 100
No. 4	0 - 30
No. 8	0 - 10
No. 16	0 - 5

912-2.03 Admixtures:

Admixtures shall conform to the requirements of Subsection 1006-2.04 of the specifications.

Air-entraining admixtures will be required for shotcrete placed at an elevation of 3,000 feet or above and the air content shall be 7 percent plus or minus 2 percent, when measured prior to pumping. At other elevations, air entraining admixtures may be used at the discretion of the contractor/mix designer and shall conform to the approved mix design. Air content will be measured in accordance with AASHTO T 152.

912-2.04 Reinforcing Steel:

Reinforcing steel bars or welded wire fabric shall conform to the requirements of Section 1003 of the specifications.

912-2.05 Equipment:

Equipment for use with the dry mix process shall be capable of metering the aggregate-cement mixture into the delivery hose under close control and delivering a continuous smooth stream of uniformly mixed material at the proper velocity to the discharge nozzle. The nozzle shall be equipped with a manually operated water ring for directing an even distribution of water through the fine aggregate-cement mixture. The water ring shall be capable of ready adjustment to vary the quantity of water.

Equipment for use with the wet mix process shall be the pneumatic feed type; however, a positive displacement type may be used if permitted in writing by the Engineer. The pneumatic feed type shall be capable of discharging the concrete or premixed mortar accurately, uniformly, and continuously through the delivery hose and to the gunning nozzle. The nozzle shall be fitted with an air ring for injecting additional compressed air into the flow of material. The size of the delivery hose shall be within the range of 1-1/4 to 2-1/2 inches.

912-2.06 Air Supply:

The air compressor shall have ample capacity to furnish an adequate supply of clean dry air for maintaining sufficient nozzle velocity for all phases of the work while simultaneously operating a blow pipe for clearing away the rebound. The air hose shall be equipped with a filter to prevent any oil or grease from contaminating the shotcrete.

A constant air pressure of not less than 80 pounds per square inch shall be maintained in the placing machine when using the dry mix process or at the nozzle when using the wet mix process and when the delivery hose length is 100 feet or less. The pressure shall be increased at least

5 pounds per square inch for each additional 50 feet of hose or fraction thereof.

912-2.07 Synthetic Fiber:

Microfiber may be used for control of plastic shrinkage. Macrofiber may be used to provide the residual strength. The dosage rate of either product shall be as specified by the mix design.

Fibers shown on the Department's Approved Product List (APL) and meeting the requirements specified herein shall be used as reinforcement. Copies of the most current version of the APL are available on the internet from the ADOT Research Center through its Product Evaluation Program. Fibers other than those listed on the APL that meet with the requirements specified herein may be considered for use as specified in Subsection 106.14 of the specifications, upon Engineer's approval.

Fiber reinforcement shall conform to the requirements of ASTM C1116 and ASTM D7508. Fiber reinforcement shall be polymeric, made from 100 percent virgin materials, non-corrosive, non-magnetic, and 100 percent alkali free.

Microfiber shall have a diameter of less than 0.012 in. (0.3 mm) and be clearly defined as a microfiber on the manufacturers technical data sheets.

Macrofiber shall have a minimum diameter of 0.012 in. (0.3 mm) and be clearly defined as a macrofiber on the manufacturers technical data sheets

The specific type, size, and quantity of fiber shall be determined by the mix designer and approved by the Engineer.

912-3 Construction Requirements:

912-3.01 Proportioning and Mixing:

(A) Wet Mix Process:

(1) Premixed Mortar:

Premixed mortar shall consist of not less than 564 pounds of combined Portland cement and supplementary cementitious material per cubic yard, fine aggregate, chemical and/or air-entraining admixtures, and water mixed to a desired consistency, generally to a slump in the range of 1-1/4 to 4 inches.

The material may be mixed at a central mixing plant or at the project site. If mixing is done at the project site, the mixer shall be capable of

thoroughly mixing the specified materials in sufficient quantity to maintain continuous placing of the mortar.

(2) Concrete:

The contractor shall determine the mix proportions and shall furnish concrete for pneumatic placement which contains a minimum of 658 pounds of combined Portland cement and supplementary cementitious material per cubic yard of concrete and which attains a minimum 28-day compressive strength of 3,000 pounds per square inch, unless otherwise specified. Fine aggregate and coarse aggregate shall conform to the requirements of Subsection 912-2.02 of the specifications. The total mix shall contain 15 to 20 percent coarse aggregate, by weight. The water/cementitious material ratio shall not exceed 0.50. In no case shall the slump be greater than 4 inches.

If ready-mixed concrete is used, it shall conform to the requirements of ASTM C 94.

If microfiber is used in the mix design, the dosage rate shall be determined to provide a minimum of 40% reduction in plastic shrinkage cracking when tested in accordance with ASTM C1579.

If macrofiber is used in the mix design, the dosage rate shall be determined to meet either the average equivalent flexural strength, or residual strength at a deflection of L/150, fd150 determined in accordance with ASTM C1609, using a load support apparatus compliant with the requirements of ASTM C1812.

912-3.02 Preparation of Surfaces:

The surfaces on which shotcrete is to be placed shall be finely graded to the lines and grades shown on the project plans or established by the Engineer. The surfaces shall be thoroughly compacted and shall be uniformly moistened so that water will not be drawn from the freshly placed shotcrete.

912-3.03 Forms and Ground Wires:

Forms shall be of plywood sheathing or other suitable material and shall be true to line and grade and sufficiently rigid to resist deflection during placement of the shotcrete. Forms shall be constructed to permit the escape of air and rebound during the gunning operation.

Ground or gauging wires shall be installed where necessary to establish the thicknesses, surface planes and finish lines of the shotcrete.

912-3.04 Steel Reinforcement:

Reinforcement shown on the plans shall consist of continuous steel reinforcement conforming to the requirements of Section 605 of the specifications or synthetic fiber reinforcement meeting requirements of Subsection 912-3.01 of the specifications which meet or exceed the performance of the steel required in Section 605 of the specifications.

912-3.05 Placement of Shotcrete:

The velocity of the shotcrete as it leaves the nozzle shall be maintained uniform and at a rate approved by the Engineer for the given job conditions. The nozzle shall be held perpendicular to the working surface and at a proper distance, generally between 2 and 5 feet, to ensure maximum compaction with minimum rebound of the shotcrete.

Rebound or previously expended material in the shotcrete mix shall not be used in any portion of the work. All rebound shall be removed prior to final set and before placement of the shotcrete on adjacent surfaces.

Shotcrete shall not be applied during any precipitation which is of sufficient intensity to cause the in-place shotcrete to run. Shotcrete shall not be applied during wind conditions that cause separation of the nozzle flow.

Shotcrete shall not be applied when a descending ambient air temperature falls below 40 degrees F nor until an ascending air temperature rises above 35 degrees F. Temperature shall be taken in the shade away from artificial heat.

912-3.06 Testing:

Tests to determine the physical quality of the shotcrete will be performed by the Engineer during the work as required. The contractor shall prepare test panels and obtain cores as specified herein.

Test panels at least 12 inches square and as thick as the structure being constructed, but not less than 3 inches thick, shall be prepared by gunning shotcrete mix into a frame which has been placed on a flat piece of plywood. Test panels shall be cured in the same manner as the production work, as specified in Subsection 912-3.09 of the specifications.

The contractor shall obtain three cores from each test panel in accordance with AASHTO T 24. The cores shall have a minimum diameter of 3 inches and a length to a diameter ratio (L/D) of at least 1.00. The cores must be obtained under the observation of an ADOT representative.

The cut surfaces of the cores will be carefully examined for soundness and uniformity of the material and shall be free from laminations and sand pockets.

The three cores will be tested by the Engineer for 28-day compressive strength in accordance with AASHTO T 24. Unless otherwise specified, the cores shall have an average compressive strength of at least 3,000 pounds per square inch.

912-3.07 Construction Joints:

Construction joints shall be tapered to a shallow edge of 1 inch thick over a width of 1 foot, except where the joint will be subjected to compressive loading. If such is the case, or if joints are at slab intersections, full depth vertical joints shall be constructed and special care taken to avoid or remove trapped rebound at the joint. The entire joint shall be thoroughly cleaned and wetted prior to the application of additional shotcrete.

912-3.08 Finishing:

The shotcrete shall be placed as nearly as practicable to the required thickness and shape outlined by forms and ground wires. Unless otherwise specified, the surface of the shotcrete shall have a natural gun finish.

912-3.09 Curing:

The shotcrete surfaces shall be kept continuously moist for at least seven days, beginning immediately after finishing, by means of either a water spray or fog system capable of being applied continuously or by liquid membrane-forming compound or by polyethylene sheeting conforming to the requirements specified in ASTM C171.

If polyethylene sheeting is used, it shall be white opaque and adjoining sheets shall overlap at least 12 inches and the laps secured to provide an airtight and windproof joint. If liquid membrane-forming compound is used it shall be Type I conforming to the requirements of ASTM C309 and the application rate shall be 1 gallon per 100 square feet.

912-4 Method of Measurement:

Shotcrete will be measured by the square yard of surface areas placed to the required thickness.

No measurement will be made of unexposed surfaces such as support slabs at joints, integral curb faces, or cut-off walls.

912-5 Basis of Payment:

Payment for shotcrete will be made at the contract unit price per square yard, complete in place, including excavating, backfilling, fine grading, compaction, and reinforcement.

SECTION 913 BANK PROTECTION:

913-1 Description:

The work under this section shall consist of furnishing all materials and constructing bank protection in accordance with the details shown on the plans and the requirements of the specifications.

Bank protection shall be dumped riprap, grouted riprap, wire tied riprap, riprap in wire baskets or gabions, soil-cement, and other types of bank protection and shall be constructed at the locations and as shown on the plans.

913-2 Materials:

913-2.01 Riprap Bank Protection:

(A) Rock:

Rock shall be sound and durable, free from clay or shale seams, cracks or other structural defects.

The bulk (SSD) specific gravity of the rock shall be a minimum of 2.4 as determined in accordance with the requirements of AASHTO T 85.

Rock used to construct dumped riprap shall be angular in shape. Rock used to construct other types of bank protection may be rounded stones or boulders. Rock shall have a least dimension not less than one-third of its greatest dimension and a gradation in reasonable conformity with that shown herein for the various types of bank protection. Control of the gradation will be by visual inspection.

When a source of rock is designated by the Department, it shall be the contractor's responsibility to negotiate for the material, obtain the right-of-way, and pay all royalties and damages.

The acceptability of the rock will be determined by the Engineer by visual inspection and/or testing. If testing is required, suitable samples of rock shall be taken in the presence of the Engineer at least 25 days in advance of its expected use. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from that quarry.

During construction of the bank protection, the contractor shall provide two samples of rock for the intended use. The amount of each sample for dumped riprap and riprap (slope mattress) shall be at least five tons. The amount of each sample for grouted riprap, wire tied riprap, gabions, and rail bank protection shall be at least 500 pounds. One sample shall be provided at the construction site and may be a part of the finished bank protection. The other sample shall be provided at the quarry.

These samples will be used as a frequent reference for judging the gradation of the rock supplied. Any difference of opinion between the Engineer and the contractor shall be resolved by checking the gradation of two random samples of the rock.

Material that is deemed unacceptable by the Engineer shall be replaced with acceptable material at no additional cost to the Department.

(1) Grouted Riprap:

Gradation of the rock for grouted riprap shall be as specified in the Special Provisions or as shown on the plans.

(2) Wire Tied Riprap:

Rock for wire tied riprap shall be well graded with at least 95 percent exceeding the least dimension of the wire mesh opening. The maximum size rock, measured normal to the mat, shall not exceed the mat thickness.

(3) Dumped Riprap:

Gradation of the rock for dumped riprap shall be as shown on the plans or as specified in the Special Provisions.

All equipment, sorting sites, and labor needed to check gradation shall be provided by the contractor at no additional cost to the Department.

(4) Gabions:

Rock for gabions shall be well graded, varying in size from 4 to 8 inches.

(5) Riprap (Slope Mattress):

Rock for slope mattress shall be well graded with 70 percent exceeding three inches. The maximum dimension of a single rock shall not exceed the least dimension of the gabion.

(6) Rail Bank Protection:

Rail bank protection rock shall be well graded, varying in size from 4 to 12 inches.

(B) Metal Items:

(1) Wire Fabric:

Welded wire fabric shall be galvanized and shall conform to the requirements of AASHTO M 336, except that the minimum weight of the zinc coating shall be 0.15 ounces per square foot of actual surface.

Woven wire fabric shall be galvanized and shall conform to the requirements of ASTM A116, except that the minimum weight of the zinc coating shall conform to the requirements of ASTM A641, Class 3.

Wire fabric shall be of the diameter, spacing, pattern, and dimensions shown on the plans. The selvage on each sheet of mesh shall be galvanized steel wire with a minimum diameter 25 percent larger than that used in the body of the mesh.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted to the Engineer.

(2) Miscellaneous Fittings and Hardware:

Miscellaneous fittings and hardware shall be of the type and size provided by the manufacturer of the major item to which they apply and shall be galvanized in accordance with the requirements of AASHTO M 232.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted to the Engineer.

(3) Tie Wires:

Tie wires shall be of good commercial quality and the size shall be as shown on the plans, except that the minimum weight of the zinc coating shall conform to the requirements of ASTM A641, Class 3. The contractor may use approved wire fasteners on gabions, slope mattresses, or wire fabric in lieu of tie wires.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted to the Engineer.

(4) Steel Cable:

Steel cable shall be zinc-coated steel structural wire rope conforming to the requirements of ASTM A475, seven-wire strand, Class A, for the diameter shown on the plans.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted to the Engineer.

(5) Railroad Rail:

Railroad rails may be new or used. If used rails are furnished, they shall be free from rust and equal to at least 95 percent of the original section.

(6) Soil Anchor Stakes:

Soil anchor stakes shall be made of steel and of the length shown on the plans. When not specified to be railroad rails, the following items may be used: crane rails with a weight of at least 40 pounds per linear foot, 2-inch diameter steel pipe conforming to the requirements of ASTM A53, or 3-inch by 3-inch by 3/8-inch structural steel angles conforming to the requirements of ASTM A36. Used rails, pipes or angles may be used provided the material is not rusted or damaged to the extent that the strength of the item is reduced to less than 90 percent of a new item of the same type and size.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted to the Engineer.

(C) Bedding Material:

Bedding material shall consist of granular material having a maximum dimension of 2 inches and shall be free of clay or organic material.

(D) Grout:

Grout shall consist of Portland cement, aggregate, and water. It may also contain supplementary cementitious material. Portland cement, aggregate, water, and supplementary cementitious material shall conform to the requirements of Section 1006 of the specifications. Chemical admixtures may be used and shall conform to the requirements of Subsection 1006-2.04 of the specifications, except no admixtures containing chlorides or nitrates shall be used. Air-entraining admixtures, conforming to the requirements of Subsections 1006-2.04 and 1006-3.01(E) of the specifications, shall be required for grout placed at elevations of 3,000 feet or above.

The grout shall meet the requirements shown in Table 1:

TABLE 1

Minimum Cementitious Material Content: Lbs per CY (See Note 1)	**Maximum Water/Cementitious Material Ratio (w/cm): Lb./Lb.**	**Slump: Inches** (See Note 2)	**Air Content: Percent** (See Note 3)
850	0.60	9 ± 2	0 – 8

Notes:

(1) A maximum of 25 percent of the cementitious material, by weight, may consist of an approved Class F fly ash, conforming to the requirements of ASTM C618.

(2) The slump shall be in the appropriate range to permit gravity flow into the interstices with limited spading and brooming.

The consistency of the grout shall be as approved by the Engineer.

(3) For placement of grout at elevations of 3,000 feet or above, the air content shall be a minimum of 4 percent and a maximum of 8 percent.

The mix shall consist of fine aggregate; however, the contractor may use No. 8 coarse aggregate in the grout. If No. 8 coarse aggregate is used, the volume shall be a maximum of 35 percent of the total aggregate volume.

For plant-mixed grout, the proportioning, mixing, and placing shall be in accordance with the applicable requirements in Section 1006 of the specifications.

For on-site mixing, grout that has been mixed more than one hour shall not be used.

Retempering of grout will not be permitted.

(E) Bank Protection Fabric:

Fabric shall be supplied in accordance with and conform to the material requirements of Subsections 1014-1 and 1014-5 of the specifications, respectively. Special attention shall be given to the required survivability of the fabric.

The identification, packaging, handling, and storage of the geotextile fabric shall be in accordance with ASTM D4873. Fabric rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Rolls shall be stored on-site or at another storage location in a manner which protects them from the elements. If stored outdoors, rolls shall be elevated and protected with a waterproof, light colored, opaque cover. At no time, shall the fabric be exposed to sunlight for a period exceeding 14 days.

(F) Sacked Concrete:

Sacked concrete shall be utility concrete conforming to the requirements of Section 922 of the specifications, except that the minimum cement content shall be 376 pounds per cubic yard; the slump shall be from 3 to 5 inches; and the aggregate shall conform to the gradation requirements shown in Table 2 when tested in accordance with the requirements of AASHTO T 11 and AASHTO T 27:

TABLE 2	
Sieve Size	**Percent Passing**
2 inch	100
1/4 inch	45 - 89
No. 200	0 - 12

Sacks for sacked concrete riprap shall be made of at least AASHTO M 182, Class 3, burlap and shall be approximately 19-1/2 by 36 inches measured inside the seams when the sack is laid flat, with an approximate capacity of 1-1/4 cubic feet. Sound, reclaimed sacks may be used.

913-2.02 Soil-Cement Bank Protection:

(A) Hydraulic Cement, Fly Ash, and Water:

Hydraulic cement, fly ash, and water shall conform to the requirements of Subsection 1006-2 of the specifications.

(B) Soil-Aggregate:

The source of soil-aggregate materials shall be the responsibility of the contractor. The contractor shall be solely responsible for the construction of the stockpile(s), including monitoring for quality and uniformity of the material placed therein. The soil-aggregate used in the soil-cement mixture shall consist of stones, gravel or other approved inert material of similar characteristics, and shall be clean and free from vegetable matter and other deleterious substances. Soil-cement aggregate shall conform to the gradation requirements shown in Table 3 when tested in accordance with AASHTO T 11 and AASHTO T 27:

TABLE 3	
Soil-Cement Aggregate	
Sieve Size	**Percent Passing**
1-1/2 in	98 - 100
No. 4	60 - 90
No. 200	5 - 15

Class 2 ABC may be used in-lieu of aggregate meeting the requirements of the table 3. The contractor may submit a request to use alternate material to the Engineer for review and approval.

The Plasticity Index shall be a maximum of seven when tested in accordance with the requirements of AASHTO T 90.

Clay lumps larger than 1 inch shall be removed.

When soil-aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and level. The bottom six inch layer of aggregate stored on the ground shall not be disturbed or used.

The debris or waste material resulting from the clearing and preparing of the site shall be disposed of in accordance with Subsection 201-3.02 of the specifications.

(C) Mix Design Requirements for Soil-Cement Bank Protection:

Utilizing soil-aggregate, cementitious material, and water, a mix design conforming to the requirements specified herein shall be formulated and submitted by the contractor to the Engineer for approval prior to incorporating any of the material into the work.

The amount of cement shall be determined by laboratory testing by the contractor in accordance with Arizona Test Method 220. For mix design purposes only, the cement content of the soil-cement mixture shall be determined as the cement content which yields a seven day compressive strength of 1250 psi for the soil-cement mixture.

The percent of cement to be used in the mix shall be calculated to be the weight of cement divided by the total weight of the dry compacted soil-cement.

Included in the mix design data shall be the grade of cement, brand of fly ash, and the source of aggregate. A new mix design shall be submitted for approval any time the contractor requests a change in soil-aggregate source from that given in the approved mix designs.

913-3 Construction Requirements:

913-3.01 Riprap Bank Protection:

Areas on which bank protection is to be constructed shall be cleared, grubbed, and excavated or backfilled in accordance with the requirements of the appropriate sections of Division II to produce a ground surface in reasonable conformance with the lines and grades shown on the project plans or established by the Engineer.

Placement through water will not be permitted unless otherwise approved by the Engineer.

Areas which are excavated for installation of rail bank protection shall be backfilled to original ground or to the lines and grades shown on the plans.

(A) Bank Protection Fabric:

When fabric is required, it shall be placed in the manner and at the locations shown on the plans. The surface to receive the fabric shall be free of obstructions, depressions and debris. The fabric shall be loosely laid and not placed in a stretched condition.

The strips shall be placed to provide a minimum 24 inches of overlap for each joint. On horizontal joints, the uphill strip shall overlap the downhill strip. On vertical joints, the upstream strip shall overlap the downstream strip. The fabric shall be protected at all times during construction from extensive exposure to sunlight.

When the maximum size of the rock to be placed on fabric exceeds 18 inches, the fabric shall be protected during the placement of the rock by a layer of bedding material. The bedding material shall be spread uniformly on the fabric to a depth of 4 inches and shall be free of mounds, dips or windrows. Compaction of the bedding material will not be required.

Rock shall be carefully placed on the bedding material and fabric in such a manner as not to damage the fabric. If, in the opinion of the Engineer, the fabric is damaged or displaced to the extent that it cannot function as intended, the contractor shall remove the rock, regrade the area if necessary, and replace the fabric.

(B) Dumped Riprap:

The rock shall be placed to its specified thickness in one operation and in a manner which will produce a reasonably well graded mass with a minimum amount of voids and with the larger rock evenly distributed throughout the mass.

No method of placing the rock that will cause segregation will be allowed. Hand placing or rearranging of individual rock may be necessary to obtain the specified results.

(C) Wire-Tied Riprap:

After installation of the lower portion of the wire mesh, rock shall be placed in accordance with the requirements of Subsection 913-3.01(B) of the specifications.

After placement of the rock, the upper portion of the wire mesh shall be placed, laced, and tied in accordance with the details shown on the plans.

(D) Grouted Riprap:

Rock for grouted riprap shall be placed in accordance with the requirements of Subsection 913-3.01(B) of the specifications. The stones shall be thoroughly moistened and any excess of fines shall be sluiced to the underside of the stone blanket before grouting.

The grout may be delivered to the place of final deposit by any means that will ensure uniformity and prevent segregation of the grout. If penetration of grout is not obtained by gravity flow into the interstices, the grout shall be spaded or rodded to completely fill the voids in the

stone blanket. Pressure grouting shall not unseat the stones, and during placing by this method, the grout shall be spaded or rodded into the voids.

Penetration of the grout shall be to the depth specified on the plans. When a rough surface is specified, stones shall be brushed until from 25 to 50 percent of the depth of the maximum size stone is exposed. For a smooth surface, grout shall fill the interstices to within 1/2 inch of the surface.

Grout shall not be placed when the descending air temperature falls below 40 degrees Fahrenheit nor until the ascending air temperature rises above 35 degrees Fahrenheit. Temperatures shall be taken in the shade away from artificial heat.

Curing of the grout shall be in accordance with the requirements of Subsection 912-3.09 of the specifications.

The contractor may use shotcrete conforming to the requirements of Section 912 of the specifications in lieu of grout.

(E) Slope Mattress Riprap:

The mattress bed shall be excavated to the width, line and grade as shown on the plans. The mattress shall be founded on this bed and laid to the lines and dimensions required.

Excavation for toe or cut-off walls shall be made to the neat lines of the wall.

Mattresses shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into rectangular units of the specified sizes. Mattresses are to be of single unit construction, the base, ends and sides either to be woven into a single unit or one edge of these members connected to the base section of the unit in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

All perimeter edges of the mattresses are to be securely selvaged or bound so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

Mattresses shall be placed to conform to the details shown on the plans. Stones shall be placed in close contact within the unit so that maximum fill is obtained. The units may be filled by machine with sufficient hand work to accomplish the requirements of this specification.

Broken concrete shall not be used in slope mattresses.

Before the mattress units are filled, the longitudinal and lateral edge surfaces of adjoining units shall be tightly connected by means of wire ties placed every four inches or by a spiral tie having a complete loop every four inches. The lid edges of each unit shall be connected in a similar manner to adjacent units. The slope mattress shall be anchored as shown on the plans. Each anchor stake shall be fastened to the cover mesh with a tie wire.

(F) Gabions:

The gabion bed shall be excavated to the width, line and grade as shown on the plans. The gabions shall be founded on this bed and laid to the lines and dimensions required.

Excavation for toe or cut-off walls shall be made to the neat lines of the wall.

Gabions shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into rectangular units of the specified sizes. Gabions are to be of single unit construction, the base, ends and sides either to be woven into a single unit or one edge of these members connected to the base section of the unit in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

Where the length of the gabion exceeds its horizontal width, the gabion is to be equally divided by diaphragms, of the same mesh type as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base section in such a manner that no additional tying at this juncture will be necessary.

All perimeter edges of gabions are to be securely selvaged or bound so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

Gabions shall be placed to conform to the details shown on the plans. Stones shall be placed in close contact in the unit so that maximum fill is obtained. The units may be filled by machine with sufficient hand work to accomplish requirements of this specification.

The exposed face or faces shall be hand-placed using selected stones to prevent bulging of the gabion cell and to improve appearance. Each cell shall be filled in three lifts.

Two connecting tie wires shall be placed as shown on the plans between each lift in each cell.

Care shall be taken to protect the vertical panels and diaphragms from being bent during filling operations.

The last lift of stones in each cell shall be level with the top of the gabion in order to properly close the lid and provide an even surface for the next course.

All gabion units shall be tied together each to its neighbor along all contacting edges in order to form a continuous connecting structure.

Empty gabions stacked on filled gabions shall be laced to the filled gabion at the front, side and back.

(G) Sacked Concrete Riprap:

The sacks shall be filled with concrete, loosely packed so as to leave room for folding or tying at the top. Approximately one cubic foot of concrete shall be placed in each sack. Immediately after filling, the sacks shall be placed according to the details shown on the plans and lightly trampled to cause them to conform with the earth face and to adjacent sacks in place.

The first two courses shall provide a foundation of double thickness. The first foundation course shall consist of a double row of stretchers laid level and adjacent to each other in a neatly trimmed trench. The trench shall be cut back into the slope a sufficient distance to enable proper subsequent placement of the riprap. The second foundation course shall consist of a row of headers placed directly above the double row of stretchers. The third and remaining courses shall consist of a double row of stretchers and shall be placed in such a manner that joints in succeeding courses are staggered.

All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon. Stretchers shall be placed so that the folded ends will not be adjacent. Headers shall be placed with the folds toward the earth face. Not more than four vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

When there will not be proper bearing or bond for the concrete because of delays in placing succeeding layers of sacks, a small trench shall be excavated back of the row of sacks already in place, and the trench shall be filled with fresh concrete before the next layer of sacks is laid. The size of the trench and the concrete used for this purpose shall be approved by the Engineer. The Engineer may require header courses at any level to provide additional stability to the riprap.

Sacked concrete riprap shall be cured by being covered with a blanket of wet earth or by being sprinkled with a fine spray of water every two hours during the daytime for a period of four days.

(H) Rail Bank Protection:

Excavation, where required for rock fill, shall be performed in reasonably close conformity to the lines and grades established or shown on the plans.

Rails shall be driven at the locations and to the minimum penetrations shown on the plans. Driving equipment shall be capable of developing sufficient energy to drive the rails to the specified minimum penetration and be approved by the Engineer.

If hard material is encountered during driving before minimum penetration is reached and it has been demonstrated to the satisfaction of the Engineer that additional attempts at driving would result in damage to the rails, the Engineer may order additional work to be performed, such as jetting or drilling, in order that minimum penetration may be obtained or the Engineer may order the minimum penetration to be reduced as required by the conditions encountered.

Wire fabric shall be securely fastened to the rails, placed in the trenches and laid on the slopes. The rock backfill shall then be carefully placed so as not to displace the wire fabric or rails. The wire fabric shall entirely enclose the rock backfill.

The completed rock fill shall be backfilled as necessary and the waste material disposed of as directed by the Engineer.

913-3.02 Soil-Cement Bank Protection:

Soil-cement bank protection construction shall include excavating, backfilling, and grading the wash bed and banks to the lines, grades and cross sections shown on the plans or established by the Engineer; furnishing and mixing aggregate, cement, fly ash and water; and spreading, compacting, and curing the mixture.

The contractor shall investigate for ground water as soon as possible. If there is a need for dewatering, the contractor shall provide to the Engineer for review a comprehensive dewatering plan a minimum of two weeks before construction starts. The dewatering plan shall address any water quality requirements of the Corps of Engineers permit and ADEQ certification. Dewatering activities shall not begin until the Engineer has approved the plan.

The dewatering shall comply with all laws and permit requirements.

If changes to the approved dewatering plan are required, the contractor shall submit a revised plan to the Engineer for approval.

For soil-cement bank protection, the contractor shall be responsible for quality control as necessary to meet the requirements established herein. The contractor shall monitor the complete mix during construction of soil-cement, including the amounts of cement and fly ash used.

(A) Required Contractor Submittals:

Two weeks prior to the start of the soil-cement bank protection construction, the contractor shall submit in writing to the Engineer for approval, the following items:

(1) The type of spreading and compaction equipment to be used.

(2) The number and type of watering equipment to be used.

(3) The method used to keep surfaces continuously moist until subsequent layers of soil-cement are placed.

(4) The method used to cure permanently exposed surfaces.

(5) The proposed source of soil-aggregate.

(6) The proposed source(s) of Portland cement and fly ash (if used).

(7) The approximate length of soil-cement bank protection or area of soil-cement to be placed each day prior to starting placement and compaction operations, on a daily basis.

(8) The soil-cement mix design.

Such submittals shall not relieve the contractor of the responsibility for achieving the desired result of constructing sound soil-cement, free from defects, according to the specifications and plans, or as directed by the Engineer. Changes in the source(s) of cement or fly ash will not be permitted without the prior approval of the Engineer.

(B) Preparation of Subgrade:

Before placement of the soil-cement, the area to be treated shall be graded and shaped to the lines and grades as shown on the plans. The subgrade shall be compacted to a minimum of 95 percent of the maximum dry density determined in accordance with AASHTO T 99. The subgrade shall be compacted at a moisture content within two percentage points of the optimum moisture content determined in accordance with AASHTO T 99.

When the embankment material is composed predominantly of rock such that these compaction control procedures will not indicate the density achieved, the Engineer will determine the amount of compaction required and the adequacy of equipment used in obtaining the required compaction. Immediately prior to placement of the soil-cement mixture, the subgrade within the lines and grades of the plans shall be moistened

and any soft or yielding subgrade shall be corrected and made stable before construction proceeds in accordance with requirements of Subsection 203-5.03(A) of the specifications. Any additional subgrade reparations required outside of the lines and grades shown on the plans, as determined by the Engineer, shall be repaired by the contractor and paid for by Force Account.

(C) Mixing Plant:

Aggregate and cementitious materials for the soil-cement shall be proportioned and mixed in a central mixing plant. The mixing plant shall be either of the batch-mixing type using revolving blade, rotary drum mixers, or of the continuous mixing type using a stationary twin shaft pug mill mixer. The aggregate, fly ash, and cement shall be proportioned by weight. The mixing plant shall be designed, coordinated, and operated to produce a soil-cement mixture of the proportions specified within required tolerances.

If the soil-cement temperatures measured at the mixer are 85 degrees Fahrenheit or less, the placing and compaction shall be completed within 1-1/2 hours of the batch time. If soil-cement temperatures measured at the mixer are greater than 85 degrees Fahrenheit but less than 96 degrees Fahrenheit, placing and compaction shall be completed within 1 hour of the batch time. If soil-cement temperatures are 96 degrees Fahrenheit or greater when measured at the mixer, the contractor shall take immediate steps to lower the batch plant mix temperature to 95 degrees Fahrenheit or below, and follow the above time limits as mix temperature dictates, prior to further placement and compaction of soil-cement materials.

The water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water utilized per batch or the rate of water flow utilized for continuous mixing.

(1) Measuring Devices:

The mixing plant shall record the quantity of the material, shall have a digital readout, and shall provide daily printed record such that the total discharged quantity per hour and the cumulative total quantity are displayed.

Measuring devices shall be calibrated and approved by the Engineer.

Each weight measuring device shall be calibrated to an accuracy of 0.2 percent and shall be inspected and calibrated as often as the Engineer deems necessary to assure their accuracy.

Each volume measuring device shall be calibrated to an accuracy of ± 1.5 percent and shall be inspected and calibrated as often as the Engineer deems necessary to assure their accuracy.

(2) Batch Mixing:

The mixer shall be equipped with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch. The mixer shall be equipped with a timing device which will indicate, by a definite audible or visual signal, the expiration of the mixing period. The device shall be accurate to within two seconds. The allowable tolerance for weight batching of aggregates and cementitious material shall be two percent and 0.5 percent, respectively, for each batch.

The batch mixing plants shall provide sampling facilities which are satisfactory to the Engineer and which allow representative samples of the soil-aggregate mixture prior to the addition of water and cementitious material to be obtained easily and safely. Samples of the soil-aggregate will be taken at this point to determine conformance to the gradation and plasticity requirements listed in Subsection 913-2.02(B) of the specifications.

(3) Continuous Mixing:

Aggregates shall be drawn from the storage facility by a feeder or feeders which will continuously supply the correct amount of soil-aggregate in proportion to the cementitious material.

A control system shall be provided that will automatically close down the plant when material in any storage facility approaches the strike off capacity of the feed gate. The plant will not be permitted to operate unless this automatic control system is in good working condition. The feeder for the soil-aggregate shall be mechanically or electrically driven.

Continuous mix plants shall provide sampling facilities which are satisfactory to the Engineer and which allow representative samples of the soil-aggregate mixture prior to the addition of water and cementitious material to be obtained easily and safely. Samples of the soil-aggregate will be taken at this point to determine conformance to the gradation and plasticity requirements listed in Subsection 913-2.02(B) of the specifications.

(4) Blending of Cement and Fly Ash:

The blending procedure shall be sufficient to provide a uniform, thorough, and consistent blend of cement and fly ash. The blending method and operation shall be approved by the Engineer prior to the commencement of soil-cement production. During blending of the cementitious materials, the percent of fly ash content shall not vary by more than ± 0.5 percent of the content approved by the Engineer.

Weight measuring devices are required at both the cement and fly ash feeds. At the direction of the Engineer, an additional measuring device may also be required when the cement and fly ash are pre-blended at the site. In the production of the soil-cement mixture, the percent of

cementitious material shall not vary by more than ± 0.5 percent of the contents approved by the Engineer.

Silos and feeders shall be equipped and operated so as to provide uniform rates of feed and prevent caking. The charge in the batch mixer or rate of feed to the continuous mixer shall not exceed that which will permit complete mixing of all the mix material. Provisions shall be made to allow for ready sampling of the cementitious materials.

(D) Transporting, Spreading, and Compaction:

The soil-cement mixture shall be transported from the mixing plant to the construction site in clean hauling equipment vehicles outfitted with suitable covers to protect the mixture in unfavorable weather.

Spreading of the soil-cement mixture shall be accomplished using equipment that will produce uniform layers of the width and thickness necessary to provide for adequate compaction in conformance with the required dimensions shown on the plans for completed soil-cement layers. Where the soil-cement is to be placed in confined areas, the lifts may be spread by other methods as approved by the Engineer.

The layers of soil-cement shall not exceed 12 inches after compaction, or be less than four inches thick after compaction, unless the contractor can demonstrate the ability to place thicker layers with the equipment being utilized in the control strip. If potholing is performed to allow testing of each lift, the recompacted material used to repair the pothole shall also be tested and meet the requirements of this specification. Each successive layer shall be placed as soon as practicable after the preceding layer is completed, and approved by the Engineer. The maximum depth of compacted soil-cement that shall be placed per day in each location is four feet, unless approved by the Engineer.

Prior to spreading new material on a previously compacted lift which has cured for more than 1-1/2 hours, or if the surface has dried due to temperature and/or wind effects, scarification of the lift shall be performed parallel with the direction of placement using equipment approved by the Engineer. The scarification shall be performed to a depth of at least two inches, spaced between 18 and 24 inches. The Engineer may waive requirements for scarification if compaction is performed by means which provide an appropriate surface for bonding with the subsequent layer.

All construction equipment, including water spray trucks, shall be restricted from entering scarified surface areas during the interim between spreading and compaction operations.

If the surface cannot be scarified, the surface shall have a cement grout slurry applied to ensure a proper bonding between lifts. The cement slurry shall have a water/cement ratio between 0.70 and 0.80 and be

approved for use by the Engineer prior to placement of any additional soil-cement mixture.

All soil-cement surfaces that will be in contact with succeeding layers of soil-cement shall be kept continuously moist by fog spraying until placement of the subsequent layer, provided that the contractor will not be required to keep such surfaces continuously moist for a period longer than seven days. Mixing and placing shall not proceed when the soil-aggregate or the area on which the soil-cement is to be placed is frozen. Soil-cement shall be mixed and placed when the air is at least 40 degrees F and rising.

(E) Monitoring Moisture Content in the Field:

Control of water content by the contractor in the field shall be accomplished in two ways:

(1) The moisture-density relationship for the soil-cement mixture shall be determined in accordance with Arizona Test Method 221 on a routine basis, or when any significant gradation shift or rock content change occurs.

(2) The actual moisture content of the mixture at the time of compaction, or shortly thereafter, shall be determined in accordance with AASHTO T 310 to determine if the optimum moisture content as determined by Arizona Test Method 221 is being maintained. The water content in the soil-cement mixture is to be continuously monitored, and the mixing water shall be adjusted at the plant as necessary to achieve the compressive strength and compaction requirements specified herein.

(F) Quality Control Compaction Testing:

Soil-cement shall be uniformly compacted to a minimum of 98 percent of the maximum dry density determined in accordance with Arizona Test Method 221. A running average of five consecutive in place density tests shall not be less than 100 percent of maximum density as monitored by nuclear density tests in accordance with AASHTO T 310. Compaction shall be performed within two percentage points of the optimum moisture content as determined in accordance with Arizona Test Method 221. Quality control density and moisture tests shall be performed in accordance with AASHTO T 310 at a minimum frequency as specified in Table 4:

TABLE 4	
Quality Control Minimum Requirements for Compaction	
Moisture/Density	1 test / 500 sy / lift

(G) Control Strips:

A control strip shall be constructed at the beginning of work on the soil-cement to be compacted. The control strip construction shall be required to establish equipment and procedures required to attain densities for the specified course.

Each control strip, constructed to acceptable density and surface tolerances shall remain in place and become a section of the completed embankment. Once control strip is complete and accepted, production may begin on the same shift for the remainder of project.

Unacceptable control strips shall be corrected or removed and replaced at the contractor's expense. A control strip shall have an area of approximately 100 square yards and shall be of the same depth specified for the construction of the course which it represents.

The materials used in the construction of the control strip shall conform to the specification requirements. They shall be furnished from the same source and shall be of the same type used in the remainder of the course represented by the control strip. The underlying surface upon which a control strip is to be constructed shall have prior approval of the Engineer.

The equipment used in the construction of the control strip shall be approved by the Engineer and shall be of the same type and weight to be used on the remainder of the course represented by the control strip.

Compaction of control strips shall commence immediately after the course has been placed to the specified thickness, and shall be continuous and uniform over the entire surface. Compaction of the control strip shall be continued until no discernable increase in density can be obtained by additional compaction effort.

Upon completion of the compaction, the mean density of the control strip will be determined by averaging the results of ten nuclear density tests taken at randomly selected sites within the control strip.

If the mean density of the control strip is less than 100 percent of the density of laboratory compacted specimens as determined by testing procedures appropriate for the material being placed, the Engineer may order the construction of another control strip.

A new control strip may also be ordered by the Engineer or requested by the contractor when:

(1) A change in the material or mix design is made.

(2) A control strip density is not representative of the material being placed.

(H) Power Tampers and Small Vibratory Rollers:

Small vibratory rollers which are capable of operating within six inches of a vertical face shall be used for compaction adjacent to the guide banks, next to the utilities and drainage conduit; at transitions to constructed levee protection, and at other areas where larger vibratory rollers cannot maneuver. The amount of rolling and tamping required shall be whatever is necessary for the particular equipment to provide the same degree of compaction as would be attained with larger self-propelled vibratory rollers. Standby replacement equipment shall be available within one hour if needed.

(I) Finishing/Trimming:

After compaction, the soil-cement shall be further shaped, if necessary, to the required lines, grades, and cross-sections and rolled to a reasonably smooth surface. Shaping of the face of the soil-cement bank protection shall be conducted daily at the completion of each day's production.

The exposed face of the soil-cement bank protection shall be trimmed to a neat line as shown on the plans. The resulting soil-cement bank protection width shall not be less than eight feet after trimming unless specified on the plans.

(J) Curing:

Whenever the atmospheric temperatures are expected to drop below 30 degrees Fahrenheit, the soil-cement shall be protected from freezing for seven days, after its construction by a covering of straw, earth, or other suitable material approved by the Engineer.

Temporarily exposed surfaces shall be kept moist as previously set forth. Care must be exercised to ensure that no curing material other than water is applied to the soil-cement surface that will be in contact with succeeding layers.

Permanently exposed surfaces shall be kept in a moist condition for seven days, or they may be covered with bituminous curing material, subject to the Engineer's approval. Any damage to the protective covering within seven days shall be repaired to the satisfaction of the Engineer at no additional cost to the Department.

Regardless of the curing material used, the permanently exposed surfaces shall be kept moist until the protective cover is applied. Such protective cover is to be applied as soon as practicable, with a maximum time limit of 24 hours between the finishing of the surface and the application of the protective cover or membrane.

(K) Backfill:

Backfill shall not be placed against the soil-cement until the contractor has achieved the compaction requirement.

(L) Maintenance:

The contractor shall maintain and protect the soil-cement in good condition until all work is completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done at no cost to the Department and repeated as often as necessary. Faulty work shall be replaced for the full depth of the layer. The contractor shall take all necessary precautions to avoid damage to the completed soil-cement by equipment, and to avoid the deposition of raw earth or foreign materials between layers of soil-cement. Where ramps are constructed over soil-cement layers which are not to grade, all foreign materials and the uppermost one inch of the previously placed soil-cement mixture must be removed prior to continuation of the soil-cement construction.

(M) Construction Joints:

Construction joints are to be provided at the end of each day's work or when work is to be halted for 90 minutes or more. The joints shall be trimmed to a 15 degree minimum skew, transverse construction joint shall be formed by cutting back into the completed work to form a vertical face to the full depth of the previous lift. Before resuming placement of new material, the joints shall be roughened and loose material shall be removed by power broom.

(N) Acceptance of Soil-Cement:

The Engineer will cast, transport, cure, and test specimens in accordance with Arizona Test Method 241 for each 1,500 cubic yards of soil cement placed. Three cylinders will be tested at seven days. The average compressive strength of the three cylinders shall achieve a minimum compressive strength of 750 psi.

Any early strength testing for the purpose of correlating seven day strength results to provide an early indicator of potentially low strength material shall be the responsibility of the contractor.

913-4 Method of Measurement:

Riprap, except gabions and sacked concrete, will be measured by the cubic yard of protection constructed by computing the surface area measured parallel to the protection surface and the total thickness of the riprap measured normal to the protection surface.

Riprap (gabions) will be measured by the cubic yard by computing the volume of the rock-filled wire baskets used.

Riprap (sacked concrete) will be measured by the cubic yard of concrete placed in the completed work. The measurement will be based on mixer volumes.

Rail bank protection will be measured by the linear foot. Measurement will be made from top of rail to top of rail (longest rail where rails of two or more lengths are used) and the distance measured will be from end rail to end rail.

Where two parallel rows of vertical rails are used, the measurement for payment will be the average of the distance along the two rows. Rail bank protection will be measured along the bank protection control line from end rail to end rail.

Soil-cement will be measured per cubic yard of soil-cement furnished and placed per the specified lines, grades, and cross-sections shown on the plans.

913-5 Basis of Payment:

The accepted quantities of riprap and rail bank protection, measured as provided above, will be paid for at the contract unit price per cubic yard or linear foot, which price shall be full compensation for the work, complete in place, including excavation; preparing the ground area; furnishing and installing the rock, filter fabric, bedding material, metal items, concrete, sacks and grout; and backfilling as required.

Materials, labor and equipment necessary to perform additional work such as jetting or drilling, as specified under Subsection 913-3.01(H) of the specifications, will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

The accepted quantities of soil-cement, measured as provided above, will be paid for at the contract unit price per cubic yard of soil-cement bank protection. Such payment shall constitute full reimbursement for all work necessary to complete the soil-cement bank protection including:

(1) Surface Preparation;
(2) Providing and Stockpiling Soil-Aggregate;
(3) Cementitious Material, Watering, Mixing;
(4) Placing;
(5) Compacting;
(6) Shaping and Finishing;
(7) Curing;
(8) Quality Control Testing; and
(9) Other Incidental Operations.

Any waste and non-compacted soil-cement material not used on the final soil-cement bank protection will not be measured for payment.

Excavation and backfill associated with the soil-cement construction will be measured and paid under the Structural Excavation and Structure Backfill items respectively.

Construction of Gabion Mattress associated with the soil-cement work will be measured and paid under the Riprap (Gabion Mattress) item.

Payment for additional excavation, where determined by the Engineer to remove unsuitable material, per the requirements of Subsection 203-5.03(A) of the specifications, will be made in accordance with the provisions of Subsection 109.04 of the specifications.

Payment for Dewatering will be made on a Force Account basis in accordance with the requirements of Subsection 109.04 of the specifications.

SECTION 914 WALLS AND MISCELLANEOUS STRUCTURES:

914-1 Description:

The work under this section consists of furnishing all materials and constructing walls and miscellaneous structures at the locations and in accordance with the details shown on the project plans.

914-2 Materials:

Concrete shall be Class S and of the compressive strength shown on the project plans. Concrete and reinforcing steel shall conform to the requirements of Sections 1006 and 1003 of the specifications, respectively. Masonry materials shall conform to the requirements specified on the project plans.

914-3 Construction Requirements:

Rustication, color coating or other wall treatments shall be in accordance with the details shown on the project plans or as specified in the Special Provisions.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of the specifications.

914-4 Method of Measurement:

Measurement of this work will be made by the square foot of wall constructed and will be measured along the front face of the wall from the top of footing to the top of wall cap.

914-5 Basis of Payment:

Payment for this work will be made at the contract price per square foot, which price shall be full compensation for the item complete, including necessary excavation, footings, backfilling, rustication and color coating as described herein and on the project plans.

SECTION 915 TEMPORARY SILT FENCE:

915-1 Description:

The work under this section shall consist of furnishing, installing, maintaining, and removing a geotextile barrier-fence designed to remove suspended particles from the water passing through it.

The temporary silt fence shall be installed in accordance with the details and at the locations as shown on the project plans. The installation shall be in accordance with the requirements of these specifications except as otherwise directed or approved by the Engineer. The quantity of temporary silt fence to be installed will be affected by the actual conditions which occur during the construction of the project.

915-2 Materials:

915-2.01 Geotextile Fabric:

The silt fence geotextile fabric shall be supplied in accordance with the material requirements of Subsections 1014-1 and 1014-8 of the specifications.

This specification provides criteria for wire supported geotextile silt fence as well as a self supporting geotextile silt fence.

915-2.02 Fabric Packaging, Handling, and Storage:

The identification, packaging, handling, and storage of the geotextile fabric shall be in accordance with ASTM D4873. Fabric rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Rolls will be stored on the site or at another identified storage location in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof, light colored, opaque cover.

915-2.03 Posts:

Posts shall be a minimum of 3 feet plus the burial depth in length and may be made of either wood or steel. Soft wood posts shall be at least 3 inches in diameter, or nominal 2-inch by 4-inch and straight enough to provide a fence without noticeable misalignment. If oak posts are used, the size may be reduced to 1-1/2 by 1-1/2 inches with a minus tolerance of 1/8 inch, provided that the cross sectional area is a minimum of 2.25 square inches. Steel posts shall have a minimum weight of 1.3 pounds per foot, and have projections for fastening the wire and fabric to the fence.

915-2.04 Wire Support Fence:

Wire support fence shall be a minimum of 32 inches high and shall be 12 gauge steel wire mesh.

915-2.05 Fasteners for Wooden Posts:

Wire staples shall be No. 17 gauge and shall have a crown at least 3/4-inch wide and legs at least 1/2-inch long. Staples shall be evenly spaced with at least five per post.

Nails shall be 14 gauge, 1 inch long with 3/4-inch button heads. Nails shall be evenly spaced with at least four per post.

915-3 Construction Requirements:

915-3.01 Silt Fence Installation:

The contractor shall install a temporary silt fence as shown on the plans, and at other locations as directed or approved by the Engineer. Fence construction shall be adequate to handle the stress from sediment loading. Geotextile at the bottom of the fence shall be buried a minimum of 6 inches in a trench so that no flow can pass under the barrier. The trench shall be backfilled and the soil compacted over the geotextile. Fence height shall be as specified by the Engineer but in no case shall exceed 36 inches above ground surface.

915-3.02 Post Installation:

Posts shall be set a minimum of 18 inches into the ground and spaced a maximum of 6 feet apart. Where an 18-inch post depth is impossible to achieve, the posts should be adequately secured to prevent overturning of the fence due to sediment loading and ponding pressure.

915-3.03 Wire Support Fence:

When wire support fence is used, the wire mesh shall be fastened securely to the upstream side of the post. The wire shall extend into the trench a minimum of 2 inches and extend a minimum of 32 inches above the original ground surface.

915-3.04 Geotextile Fabric Post Attachment:

The geotextile fabric shall be attached on the upstream side of the posts by wire, cord, button head nails, pockets, staples, or other acceptable means. The geotextile fabric shall be installed in such a manner that 8 to 10 inches of fabric is left at the bottom to be buried. The fabric shall be installed in the trench such that 6 inches of fabric is against the side of the trench and 2 to 4 inches of fabric is across the bottom of the

trench in the upstream direction. The trench shall then be backfilled and compacted so that no flow can pass under the barrier.

A minimum overlap of 18 inches shall be provided at all splice joints with posts at the ends of each fabric roll.

At the time of installation, the fabric will be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, storage or installation.

915-4 Maintenance Requirements:

915-4.01 Silt Fence Maintenance:

The contractor shall be responsible to maintain the integrity of silt fences as long as necessary to contain sediment runoff in accordance with Subsection 104.09 of the specifications, or as directed by the Engineer.

915-4.02 Sediment Deposit Removal:

Sediment deposits shall be removed when the deposit reaches approximately one-half the height of the silt fence. The Engineer may also direct the contractor to install an additional silt fence.

915-4.03 Fence Removal:

The silt fence shall remain in place until the Engineer directs that it be removed. Upon removal, the contractor shall remove and dispose of any excess silt accumulations, grade the area to leave a generally smooth appearance, and plant vegetation in the areas specified in the contract documents. The fence materials will remain the property of the contractor and may be used at other locations provided the materials are in a condition acceptable to the Engineer.

915-5 Method of Measurement:

Temporary silt fence will be measured per linear foot. No allowance will be made for extra material used in overlapping at splice joints.

Removal of sediment will be measured by the cubic yard.

915-6 Basis of Payment:

The accepted quantity of temporary silt fence, measured as provided above, will be paid for at the contract unit price per linear foot, complete in place, including all labor, materials, and equipment connected with placing the temporary silt fence as shown on the project plans or as directed by the Engineer. No payment will be made for rejected

temporary silt fence, or for patching, due to contamination or damage by the contractor.

The removal of sediment will be paid for at the contract unit price per cubic yard, including the removal and disposal of silt accumulations as provided for in the Special Provisions and the erosion control plan for the project.

SECTION 916 EMBANKMENT CURB:

916-1 Description:

The work under this section shall consist of furnishing all materials and constructing Portland cement concrete embankment curbs at the locations shown on the project plans or otherwise designated in accordance with the details shown on the plans and the requirements of the specifications.

916-2 Materials:

Portland cement, water, and admixtures shall conform to the requirements of Section 1006 of the specifications for Class B concrete, except that the 28-day compressive strength requirement shall be eliminated.

Fine aggregate and coarse aggregate shall conform to the requirements of Subsection 1006-2.03 of the specifications. The designated size of coarse aggregate shall be No. 8, No. 7, No. 67 or No. 57.

The contractor may add additional fine aggregate to the aggregate for the curb in order to facilitate finishing. Fine aggregate for this purpose shall be nonplastic and shall conform to the following grading requirements:

Sieve Size	Passing Percent
No. 4	100
No. 200	0 - 10.0

Fine aggregate added for this purpose shall not exceed 25 percent of the total aggregate for the concrete curb.

Liquid membrane-forming compound shall conform to the requirements of AASHTO M 148, Type I, Class A.

916-3 Construction Requirements:

The contractor shall be responsible for furnishing the various ingredients and for proportioning and mixing them; however, approval of the

proposed materials and proportioning and mixing shall be obtained prior to any concrete operations.

No field tests will be required on the concrete mixture.

The requirements for mixing and placing concrete in cold weather shall conform to the requirements of Subsection 1006-5.03 of the specifications. There is no maximum temperature limitation on the concrete mixture immediately before placement.

Embankment curb shall be constructed either by the use of conventional fixed forms or by slip-form curb placing machines. The surface on which the curbs are to be placed shall be cleaned of all loose dirt and debris prior to placing. The work shall be performed so as not to mar the roadway surface.

If slip-form equipment is used to construct embankment curb, such equipment shall be designed specifically for the work. The slip-form machine shall be capable of producing curb equal to or better than that produced by the use of fixed forms. If the curb produced by such machines is not acceptable, the use of such machines shall be terminated.

Curbs shall present a neat appearance. The finish normally associated with the use of slip-form curb placing machines, including the use of moveable forms, will be considered as acceptable for the finishing of concrete embankment curb. When bituminous material is being applied to the adjacent roadway, curbs shall be protected so that they are not spattered or discolored.

Embankment curb shall be cured by the application of liquid membrane-forming compound. The time at which it is to be applied and the rate of application shall be approved by the Engineer.

916-4 Method of Measurement:

Embankment curb will be measured by the linear foot of curb placed. Lengths occupied by spillway inlets will be excluded from the measurement.

916-5 Basis of Payment:

The accepted quantities of embankment curb, measured as provided above, will be paid for at the contract unit price per linear foot, complete in place.

SECTION 917 EMBANKMENT SPILLWAYS, EMBANKMENT DOWN-DRAINS, INLETS AND OUTLETS:

917-1 Description:

The work under this section shall consist of furnishing all materials and constructing embankment spillways, embankment down-drains, inlets and outlets at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

917-2 Materials:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

Concrete shall be Class B Portland cement concrete conforming to the requirements of Section 1006 of the specifications.

Welded wire fabric and wire ties shall conform to the requirements of Section 1003 of the specifications.

Steel bars for reinforcing, anchor stakes and trash racks shall conform to the requirements of Section 1003 of the specifications.

Miscellaneous structural steel shall conform to the applicable requirements of Section 1004 of the specifications.

Corrugated metal pipe shall conform to the requirements of Section 1010 of the specifications and shall be fabricated with circumferential corrugations.

Preformed bituminous joint filler shall conform to the requirements of Subsection 1011-6.01 of the specifications.

917-3 Construction Requirements:

917-3.01 General:

Embankment slopes and existing ground at outlets shall be excavated in reasonably close conformity to the lines, and grades shown on the plans or established by the Engineer.

Backfill shall be placed and compacted in accordance with the requirements of Subsection 203-10 of the specifications for embankment.

917-3.02 Concrete:

Concrete spillways, inlets and outlets shall be constructed in accordance with the requirements of Section 601 of the specifications. Reinforcing with wire mesh or steel bars where shown on the plans shall be placed in accordance with the requirements of Section 605 of the specifications.

Concrete surfaces shall be protected from discoloration.

Preformed bituminous joint material shall be placed around timber guardrail posts imbedded in concrete.

917-3.03 Metal:

Each separate down-drain installation shall be assembled from one type of pipe only. Steel and aluminum shall not be used in the same installation.

Corrugated metal pipe utilized in construction of down-drains shall be installed in accordance with the applicable requirements of Section 501 of the specifications.

917-4 Method of Measurement:

917-4.01 Embankment Spillways and Embankment Down-Drains:

Embankment spillways and embankment down-drains will be measured by the linear foot along the slope at the center line of the spillway and along the metal down-drain parallel to the center line of the pipe.

917-4.02 Inlets and Outlets:

Inlets and outlets will be measured as a unit for each installation of the type specified.

Trash racks will not be measured for separate payment, but will be considered as included in the price bid for inlets.

917-5 Basis of Payment:

The accepted quantities of embankment spillways, embankment down-drains, inlets and outlets, measured as provided above, will be paid for at the contract unit price, complete in place, including excavating and backfilling.

SECTION 918 TURNOUT CONSTRUCTION:

918-1 Description:

The work under this section consists of all necessary surface preparation and the placing, spreading, shaping and finishing of base material, asphaltic concrete, asphaltic concrete friction course or bituminous treatments, as appropriate, for turnouts which are not shown on the project plans or on typical sections, but which generally conform to and are essentially limited by the details shown on the plans.

918-2 Blank:

918-3 Construction Requirements:

All materials shall be placed, spread, shaped, compacted and finished in accordance with the construction requirements of the specifications for the specific material.

918-4 Method of Measurement:

Measurement will be made by the square yard and each turnout will be measured to the nearest square yard; however, when surface preparation or a material application is required more than once in the same area, measurement for payment will be made only once of any such area.

918-5 Basis of Payment:

Payment will be made at the contract unit price per square yard, which price shall be full compensation for the work complete in place as described and specified herein.

Payment for furnishing the various materials will be made under the respective contract items.

No payment will be made for turnouts which are shown on the project plans or on typical sections from which dimensions can be taken or can readily be determined.

SECTION 919 CONCRETE GORE PAVING:

919-1 Description:

The work under this section shall consist of furnishing aggregate base, joint filler and Portland cement concrete and constructing gore pavement at the locations and in accordance with the detailed requirements shown on the plans and in the specifications.

919-2 Materials:

919-2.01 Portland Cement Concrete:

Portland cement concrete shall conform to the requirements of Section 1006 of the specifications for Class S concrete.

919-2.02 Aggregate Base:

Aggregate base shall conform to the requirements of Subsection 303-2 of the specifications for any of the classes specified therein.

919-2.03 Joint Filler:

Joint filler shall conform to the requirements of Subsection 1011-6 of the specifications.

919-2.04 Curing Compound:

Curing shall be accomplished by any of the methods specified in Subsection 401-3.04(G) of the specifications, except that any method that may permanently discolor concrete shall not be used.

919-3 Construction Requirements:

Where material is to be placed on the existing ground surface or surface or existing subgrade to bring it up to the surface on which the aggregate base material is to be placed, the work shall be in conformance with the requirements of Subsection 203-10 of the specifications.

Aggregate base shall be placed and compacted in accordance with the requirements of Subsection 303-3 of the specifications, except that the final surface need not be fine graded or finished with a leveling device.

Finish on the concrete slab shall be a transverse coarse broom finish. Concrete shall be placed and consolidated in accordance with the requirements of Subsection 401-3.04(D) of the specifications.

919-4 Method of Measurement:

Quantities of concrete gore paving will be measured by the square yard and will be calculated on the basis of the dimensions shown on the project plans.

919-5 Basis of Payment:

The accepted quantities of concrete gore paving, measured as provided above, will be paid for at the contract unit price per square yard. The price shall include full compensation for the work complete in place,

including furnishing and placing all needed aggregate base, Portland cement concrete, joint filler and curing compound and all incidental excavation except such excavation of roadway material as is to be paid for as part of the construction of the roadway subgrade on which the aggregate base is to be placed.

SECTION 920 BLANK:

SECTION 921 CONCRETE MEDIAN PAVING:

921-1 Description:

The work under this section shall consist of furnishing aggregate base, joint filler, and Portland cement concrete, and constructing median paving at the locations and in accordance with the detailed requirements shown on the plans and in the specifications.

921-2 Materials:

921-2.01 Portland Cement Concrete:

Portland cement concrete shall conform to the requirements of Section 1006 of the specifications for Class B concrete.

921-2.02 Aggregate Base:

Aggregate base shall conform to the requirements of Subsection 303-2 of the specifications for class 1, 2, or 3 as specified therein.

921-2.03 Joint Filler:

Joint filler shall conform to the requirements of Subsection 1011-6 of the specifications.

921-2.04 Curing Compound:

Curing shall be accomplished by any of the methods specified in Subsection 1006-6.01 of the specifications, except that any method that may permanently discolor the concrete shall not be used.

921-3 Construction Requirements:

The surfaces upon which the base material is to be placed shall be fine graded and compacted to a density of not less than 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Aggregate base shall be compacted to a density of not less than 95 percent of the maximum density in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer. The final surface need not be finished with a leveling device.

The base and adjacent back of curb shall be watered immediately in advance of placing concrete. Concrete shall be placed and thoroughly consolidated by means of approved mechanical vibrators or by tamping or spading by hand. The fresh concrete shall be struck off so the surface will be at the proper elevation when the concrete is consolidated. Finish on the slab shall be a transverse coarse broom finish.

Expansion joints shall be constructed at a maximum of 60 foot intervals. Expansion joints shall be constructed between abutting structures, around poles, posts, boxes, and other fixtures that protrude through the median paving. Expansion joints shall match as nearly as possible the expansion joints in the adjacent pavement or curb. Joint filler shall be placed vertically and extend full depth beginning 3/16 inch below the surface of the concrete being placed. During the placing and tamping of concrete, the filler shall be restrained in its proper position.

Contraction joints (weakened-plane joints) shall be constructed at a maximum of 15 foot intervals and shall coincide with contraction joints in adjacent pavement or curb. A contraction joint shall be constructed longitudinally when the width of the concrete exceeds 15 feet. The concrete shall be scored for a depth of 1 inch transversely.

Immediately following the required finishing operations, all exposed surfaces shall be cured as specified in 1006-6.

Before acceptance of the work, all median paving shall be cleaned of all discolorations resulting from the contractor's operations, including, but not limited to, dirt, stains, bitumens, and equipment tire marks. Cleaning may be by abrasive blast methods or by other methods approved by the Engineer.

921-4 Method of Measurement:

Quantities of concrete median paving will be measured by the square yard of concrete placed.

921-5 Basis of Payment:

The accepted quantities of concrete median paving, measured as provided above, will be paid for at the contract unit price per square yard. The price shall include full compensation for the work complete in place, including furnishing and placing all needed aggregate base, Portland cement concrete, joint filler and curing compound and all incidental excavation.

SECTION 922 UTILITY CONCRETE FOR MISCELLANEOUS CONSTRUCTION:

922-1 Description:

The work under this section shall consist of furnishing all materials, mixing and placing Portland cement concrete for post foundations and anchors for barrier fences, line fences, chain link fences and miscellaneous signs; concrete foundations for depth gauges at fords; concrete for right-of-way markers and survey monuments; concrete rings at ground surface for irrigation valves and gates; concrete fill at the base of electrical pull boxes; and for similar uses as specified on the project plans or in the Special Provisions.

922-2 Materials:

Portland cement, water, admixture, fine aggregate and coarse aggregate shall conform to the requirements of Section 1006 of the specifications. The coarse aggregate size designation shall be chosen by the contractor and be approved by the Engineer and shall conform to the size designation and gradation requirements of AASHTO M 43.

922-3 Construction Requirements:

The Engineer will inspect and approve the facilities, materials, and methods for producing the concrete to insure that concrete of the quality suitable for use in the work will be obtained. Mixing and placing of the concrete shall conform to the requirements of recognized practice. Concrete may be mixed in mobile mixers upon approval of the Engineer.

Mixing and placing concrete in cold weather shall conform to the requirements of Subsection 1006-5.03 of the specifications. There is no maximum temperature limitation for the concrete mixture immediately prior to placement.

The minimum cement content per cubic yard of concrete shall be 470 pounds.

If approved by the Engineer, the contractor may substitute commercially available sacks of redi-mix concrete, suitable for the intended purpose. Should such substitution be approved, the cement content specified herein and the requirements of Subsection 922-2 of the specifications shall not apply.

All exposed concrete shall be finished to a smooth surface.

922-4 Method of Measurement:

No measurement will be made of the concrete used.

922-5 Basis of Payment:

No direct payment will be made for furnishing and placing utility concrete. The cost will be considered as included in the price bid for the item of work in which the concrete is incorporated.

SECTION 923 - 924 BLANK:

SECTION 925 CONSTRUCTION SURVEYING AND LAYOUT:

925-1 Description:

The work under this section shall consist of furnishing all materials, personnel, and equipment necessary to perform all surveying, staking, establishment of all pit boundaries, laying out of haul roads, and verification of the accuracy of all existing control points which have been provided by the Department. The control point verification process shall include locating and making ties to all section line, right-of-way, and roadway monuments in the vicinity of the proposed work. Included in this work shall be all calculations required for the satisfactory completion of projects, including grade and drain, overlay, safety, landscape, rest areas, structures, surfacing projects, or combinations thereof, in conformance with the plans and the specifications. The work shall include establishing and marking 'as-built' elevations on bridges, and culverts. The work shall be done under the direction of a registered professional engineer or a registered land surveyor employed by the contractor. The crew chief shall be (National Society of Professional Surveyors) NSPS Certified Level III, (National Institute for Certification in Engineering Technologies) NICET Certified Level III, or a registered Land Surveyor in Training. A minimum of 50 percent of the survey crew shall be either NSPS Certified Level II or NICET Certified Level II. All work affecting real property boundaries as described in Arizona State Board of Technical Registration Standards shall be performed under the direction of a registered land surveyor licensed in the State of Arizona.

When construction of new right-of-way monuments is included with the project, the Department will establish all initial right-of-way monuments prior to construction and forward a right-of-way staking plan to the contractor. Prior to completion of the construction project, as directed by the Engineer, the Department will supply, install, and stamp the final right-of-way markers.

All other existing cadastral corners, such as section corners, quarter corners, intersecting street centerline monuments, and property corners that are destroyed by the contractor shall be re-established by a registered land surveyor employed by the contractor.

Measurement of all pay quantity items will be the responsibility of the Department.

When utility adjustments are a part of the contract, the contractor shall perform all layout work and set all control points, stakes and references necessary for carrying out all such adjustments.

The contractor shall not employ or engage the services of any person or persons in the employ of the Arizona Department of Transportation for the performance of any of the work as described herein.

925-2 Materials, Personnel, and Equipment:

Materials and equipment shall include, but shall not necessarily be limited to, vehicles for transporting personnel and equipment, properly adjusted and accurate survey equipment, straightedges, stakes, flagging, and all other devices necessary for checking, marking, establishing and maintaining lines, grades and layout to perform the work called for in the contract. The contractor shall furnish competent personnel to perform the survey work and layout.

Traffic control devices and procedures for construction surveying shall be in accordance with the requirements of the MUTCD and associated ADOT Supplement.

Field books or other electronic data collection records used by the contractor for recording survey data and field notes shall be available for inspection by the Department at any time and shall become the property of the Department upon completion of the work.

925-3 Construction Requirements:

925-3.01 General:

At the preconstruction meeting, the contractor shall furnish to the Engineer, for approval, the following:

(A) A schedule of hourly survey services rates and classifications for additional survey work, which shall remain fixed and in effect for the entire duration of the work and shall not be subject to renegotiation; and

(B) A written outline detailing the method of staking, marking of stakes, grade control for various courses of materials, referencing, structure control, pavement markings, and any other procedures and controls necessary for survey completion. A part of this outline shall also be a schedule which will show the sequencing of the survey and layout work, throughout the course of the contract, listing a percentage of completion for each month.

When design survey is established and shown on project plans, the Department will provide a minimum of 3 control points within 1 mile of the project site, and centerline geometry information for the contractor's use. Department furnished control points set in the field will be identified to the contractor. On projects without design survey, the Department will identify record drawings from which the contractor can establish construction survey.

The contractor shall verify the accuracy of the control points established by the Department prior to use. The contractor shall, as part of the control point verification process, locate and make ties to any section line, right-of-way, and roadway monuments which will be affected by the proposed work. After verification of these points, the contractor shall notify the Department in writing of the results.

The contractor shall establish an accurate construction centerline and bench marks for the proper layout of the work as described herein.

Traverse and control points established by the contractor shall be provided to the Department as follows:

For horizontal control, the contractor shall run a traverse from which construction centerline can be established. The control points, delineated by iron pins, marks in concrete, or similar devices, shall be located to minimize the likelihood of their destruction during construction activities. Coordinates of these points or ties to construction centerline shall be provided to the Department.

For vertical control, the contractor shall establish bench marks for the entire length of the project at horizontal intervals not to exceed 2,500 feet.

Traverse or control points set by the contractor shall be identified in the field to the Department.

When GPS is utilized, the contractor will furnish the GPS localization results to the Department at least seven days before beginning construction layout survey work. The Engineer may order the GPS localization calibration and associated 3D model to be broken into two or more zones to maintain the localized relationship between control points and original ground.

The established initial right-of-way monuments shall be protected in place and re-established by the contractor, if disturbed, at no additional cost to the Department.

For locating and establishing ties to section line, right-of-way, and roadway monuments, the contractor shall follow the standards listed in Subsection 925-3.02(B) of the specifications.

Throughout the work, when design survey is established and shown on project plans, the contractor shall set all stakes including centerline stakes; offset stakes; reference point stakes; slope stakes; pavement lines, curb lines and grade stakes; stakes for sewers, roadway drainage, pipe, under drains, clearing, paved gutter, guardrail, fence, survey monuments and culverts; blue tops for subgrade, subbase and base courses; control points for bridges, bridge piers, abutments, footings, pile cutoff, pile layout, pier caps, bridge seats, bridge beams, girder profiles and screed elevations; supplemental bench marks; permanent as-built elevation marks; and all other horizontal or vertical controls necessary for complete and accurate layout and construction of the work. Regardless of the staking method, construction stakes shall be marked in such a manner that all construction personnel can easily identify the stake location, elevation, and other appropriate information. The coordinates of any new control points established by the contractor during the course of the work shall be given to the Engineer within five working days of control point establishment.

On surface treatment projects, and other projects without horizontal control, stakes indicating locations shall be placed every 500 feet, unless otherwise defined in the Special Provisions. Locations may be painted on the pavement in place of staking when approved by the Engineer.

If errors are discovered during the verification process, and control points do not agree with the geometrics shown in the plans, the contractor shall promptly notify the Engineer in writing, and explain the problem in detail. The Engineer will advise the contractor within five working days of any corrective actions which may be deemed necessary.

Directed changes to the work shall be reimbursed under Subsection 925-5 of the specifications and additional contract time may be considered for any delays.

The contractor shall be responsible for the proper layout and accuracy of all property markers which are required by the project plans.

Structure sites shall be accurately profiled and cross-sectioned, and structure control points shall be set and checked to assure the proper construction or installation of each structure. Profiles shall be approved by the Engineer prior to constructing or installing each structure. All profile survey data shall be entered in field books, or electronic reports satisfactory to the Engineer and preserved as a permanent project record.

The contractor shall exercise care in the preservation of stakes, references and bench marks and shall reset them when any are damaged, lost, displaced or removed.

On all projects, the centerline layout for the final surface course shall be established by instrument survey by the contractor and shall serve as marks for permanent traffic centerline striping. On projects requiring

contractor striping, the contractor shall set points at intervals of not greater than 50 feet for each traffic lane at the beginning and ending of each yellow stripe, and at the beginning and ending of gores and tapers.

The contractor shall also provide control points on the roadway, satisfactory to the Engineer, corresponding to the locations of all transition points for all lines of striping, including the beginnings, ends, breaks, and changes in the striping, including all tapers in the striping, and pavement edges when necessary to establish striping.

A minimum of two weeks prior to any paving activities, the contractor, the contractor's surveyors, the pavement marking subcontractor, and the Engineer shall meet to discuss the survey control for the applications of all temporary detour and permanent striping. At this meeting the contractor shall provide a written plan, satisfactory to the Engineer, to provide survey control and layout of the temporary detour and permanent striping in a timely manner.

On projects that include no-passing zones, the contractor shall also coordinate the survey layout of such zones with the ADOT No Passing Zone Crew. The contractor shall contact the ADOT No Passing Zone Crew at the phone number provided on the project plans at least five working days before placement of the related pavement marking.

On projects where traffic is being carried through the work zone, pavements shall be marked for traffic centerline delineation before the end of each work shift. Temporary pavement markings shall conform with the requirements set forth under Subsection 701-3.05 of the specifications and any subsequent modifications thereto.

Any discrepancies in grade, alignment, earthwork quantities, locations or dimensions detected by the contractor shall immediately be brought to the attention of the Engineer. No changes in the project plans will be allowed without the approval of the Engineer. Requests for verification of earthwork quantities shall be in accordance with Subsection 203-2.01 of the specifications.

The Department reserves the right to make inspections and random checks of any portion of the staking and layout work. If, in the Engineer's opinion, the work is not being performed in a manner that will assure proper controls and accuracy, the Engineer will order any or all of the staking and layout work redone at no additional cost to the Department.

If any portion of the contractor's staking and layout work is ordered redone, resulting in additional rechecking by the Department, the Department shall be reimbursed for all costs for such additional checking. The amount of such costs will be deducted from the contractor's monthly estimate.

Inspection of the contractor's layout by the Engineer and the acceptance of all or any part of it shall not relieve the contractor of its responsibility to secure the proper dimensions, grades and elevations.

925-3.02 Resetting Monuments:

(A) General:

The contractor shall be responsible to maintain all existing monumentation, including section line, right-of-way, and roadway monumentation. Monumentation disturbed during construction shall be re-established by the contractor, and recorded at the appropriate county recorder's office, at no additional cost to the Department.

(B) Monumentation Standards:

Section corner, quarter corner, and property corner monuments shall be re-established following the procedures in the Manual of Surveying Instructions 2009, published by the U.S. Department of the Interior, Bureau of Land Management, and all applicable statutes and requirements specified in the current Arizona State Board of Technical Registration's “Arizona Boundary Survey Minimum Standards.” The contractor shall also follow the ADOT Right-of-Way Standards when re-establishing right-of-way monuments.

(C) Procedures:

Section line, right-of-way, and roadway monumentation re-established by the contractor shall bear the registration number of the Land Surveyor in responsible charge of the location.

Monuments used to define section lines shall be stamped in accordance with Manual of Surveying Instructions 2009, published by the Department of Interior, Bureau of Land Management. Roadway monumentation shall be stamped in accordance with the requirements of the appropriate municipal jurisdiction. Right-of-way monuments shall be stamped in accordance with the ADOT Right-of-Way Standards.

Monuments that are re-established shall be recorded at the appropriate county recorder's office, and a copy of the Corner Recordation documentation shall be submitted to the Engineer within five working days of recordation.

925-3.03 Office Survey Work:

The contractor shall be compensated for office work associated with project survey under the following circumstances:

(A) When the project plans fail to provide sufficient information to lay out the project or any part thereof;

(B) When the contractor performs office survey work based on erroneous plans information which results in the duplication of work; and

(C) If the Department should change any plans information for which the contractor has already performed office work which results in the duplication of that work.

The contractor shall not be compensated for any office survey work that includes the following:

(A) When information provided in the plans is sufficiently complete and accurate to allow any additional information necessary for the complete layout of the project to be routinely calculated; and

(B) When the contractor fails to inform the Engineer of discovered plan errors prior to the performance of any extra office survey work.

The contractor shall inform the Engineer in a timely manner of any omissions, ambiguities, or errors which the contractor feels may result in extra office survey work, so as not to delay the project or create unnecessary calculations.

All office survey work shall be documented by the contractor and verified by the Engineer for compensation. Documentation shall consist of at least a detailed office diary specifically addressing the work involved in the alleged problem area. The contractor may be required to provide the calculations, charts, graphs, drawings, or other physical evidence which verifies the extra work.

925-3.04 Survey Manager:

The contractor shall be compensated for a survey manager when deemed necessary for extra work ordered by the Engineer. The use of a survey manager, along with all survey manager duties required as a result of the additional work, must be authorized in advance by the Engineer. The survey manager shall be a Registered Land Surveyor in the State of Arizona.

925-4 Method of Measurement:

Construction surveying and layout will be measured on a lump sum basis.

One-, two-, and three- person survey parties, survey managers, and office survey technicians will be measured by the hour to the nearest half hour.

925-5 Basis of Payment:

Payment for construction surveying and layout will be made at the contract lump sum price and will be made as follows:

> The approved schedule showing the sequencing and percentage of the survey and layout work, as submitted under Subsection 925-3.01 of the specifications, shall be the basis on which monthly progress payments shall be made. This schedule shall be subject to periodic review, at the request of the contractor or the Department, if the survey and layout work lags or accelerates. If necessary the schedule will be revised to reflect changes in survey and layout progress. When approved by the Engineer, the revised schedule will become the basis of payment.

If additional staking and layout are required as a result of additional work ordered by the Engineer, such work will be paid for in accordance with the provisions of Subsection 109.04 of the specifications.

Payment will be made utilizing the schedule of rates provided per Subsection 925-3.01 of the specifications . No additional payment will be made for overtime hours. Should such additional work require the contractor to pay travel and subsistence costs for the survey party or survey parties utilized, payment for travel and subsistence will be made under the provisions of Subsection 109.04 of the specifications. The Engineer will determine whether the additional work shall be performed by the contractor or by Department forces.

The amount per hour for a one-person, two-person, or three-person survey party includes the cost of all work necessary to complete the extra work.

Traffic control and flagging, including any necessary because of the additional staking and layout required as a result of extra work ordered by the Engineer, or additional work resulting from contract expansion and ordered by the Engineer, shall conform to the requirements of Section 701 of the specifications, Maintenance and Protection of Traffic, and will be measured and paid under the respective contract items.

No payment will be made for the resetting of stakes, references, bench marks, and other survey control unless directed by the Engineer.

The amount per hour for a survey manager and an office survey technician shall include all necessary office supplies and equipment.

Unless otherwise directed by the Engineer, requests for payment for additional survey work performed shall be submitted prior to the end of the monthly estimate billing period during which the work is performed.

SECTION 926 ENGINEER'S FIELD OFFICE:

926-1 Description:

The work under this section shall consist of furnishing a separate field office for the use by the Department's Engineering Consultant (Engineer) within the limits of the project.

The field office shall consist of a temporary building or trailer providing a minimum of 300 square feet of enclosed space and shall be provided with adequate lighting, ventilation and means of ingress and egress suitable to the intended use.

The office shall be equipped with heating and cooling equipment capable of maintaining an ambient air temperature of 70 ± 5 degrees F, a potable water supply and a separate enclosed sanitary facility with flush toilet and lavatory conforming with applicable sanitary codes. The office shall be furnished with three office desks with chairs, a drafting table with stool, and two multi-station telephones with separate lines.

The Engineer will designate the location of the office. The office shall remain on the project site for up to 30 calendar days following completion and acceptance of the work by the Department. If the project includes landscape establishment phase, the requirement specified will be applicable to the construction phase. The office shall be fully equipped with all utilities in service and shall be acceptable to the Engineer prior to commencement of any construction activity.

The contractor shall be responsible for maintaining the office and all facilities and equipment therein in good working condition. Utility costs shall be the responsibility of the contractor as well as any fees for permits, sanitary, water, electrical or gas hookups, internet access charges, installation charges, etc. The cost of long distance telephone calls made by the Engineer will be paid for by the Engineer.

Upon completion of the project and following removal of the office and any appurtenant structures, utilities, surfacing, etc., the affected areas shall be either restored to their former condition or improved as may be specified on the project plans.

926-2 Blank:

926-3 Blank:

926-4 Method of Measurement:

The engineer's field office will be measured on a lump sum basis or per month, as listed in the bidding schedule.

926-5 Basis of Payment:

Payment for the engineer's field office will be made at the contract lump sum price or contract unit price per month, which price shall be full compensation for the work complete in place, including all utility hook up charges, maintenance, and all monthly utility charges, except for long distance telephone charges made by the Engineer as herein described and specified.

Partial payments will be made in accordance with the following provisions when the work is paid on a lump sum basis:

(A) When 5 percent of the original contract amount is earned, 50 percent of the amount bid for Engineer's Field Office will be paid; and

(B) When 10 percent of the original contract amount is earned, 100 percent of the amount bid for Engineer's Field Office will be paid.

The adjustment provisions in Section 104 of the specifications and the retention of funds provisions in Section 109 of the specifications will not apply to this item.

SECTION 927 ENGINEER'S FIELD LABORATORY:

927-1 Description:

The work under this section shall consist of furnishing a separate field laboratory for the use of the Department's Materials inspection and testing personnel within the limits of the project.

The field laboratory shall consist of a temporary building or trailer providing a minimum of 300 square feet of enclosed space and shall be provided with adequate lighting, ventilation and means of ingress and egress suitable to the intended use. The building or trailer shall be so supported as to be sufficiently stable so that the required testing procedures can be performed.

The laboratory shall be equipped with heating and cooling equipment capable of maintaining an ambient air temperature of 68 to 78 degrees F, a potable water supply, and a separate enclosed sanitary facility with flush toilet and lavatory conforming to applicable sanitary codes. The laboratory shall be furnished with an office desk with chair, a drafting table with stool, and a telephone for the use of the Department. It shall be furnished with a work bench 3 feet wide by 10 feet long by 36 inches high with base cabinets and drawers for equipment storage, and with three 110-volt, 20-amp outlets above the bench, and with a service sink and water supply for testing purposes.

The Engineer will designate the location of the laboratory. The laboratory, equipped as stated above, shall remain on the site for a period not to exceed 30 calendar days following completion of the project. The office shall be fully equipped with all utilities in service and shall be acceptable to the Engineer prior to commencement of any work involving materials testing.

The contractor shall be responsible for maintaining the laboratory and all facilities and equipment therein in good working condition. Utility costs shall be the responsibility of the contractor as well as any fees for permits, sanitary, water, electrical or gas hookups, installation charges, etc. The cost of long distance telephone calls made by the Engineer will be paid for by the Engineer.

Upon completion of the work and following removal of the laboratory and any appurtenant structures, utilities, surfacing, etc., the affected areas shall be either restored to their former condition or improved as may be specified on the project plans.

927-2 Blank:

927-3 Blank:

927-4 Method of Measurement:

This work will be measured for payment by the lump sum as a single complete unit of work.

927-5 Basis of Payment:

Payment for this work will be made at the contract lump sum price which shall be full compensation for the item complete, including all labor, materials, equipment, all utility hookup charges, maintenance, and all monthly utilities charges, except for long distance telephone charges made by the Engineer as herein described and specified.

Partial payments under this item will be made in accordance with the following provisions:

(A) Sixty percent of the amount bid for Engineer's Field Laboratory will be paid with the first payment estimate after the laboratory is accepted by the Engineer; and

(B) The remaining 40 percent will be paid in approximately equal monthly payments based on the expected use of the laboratory.

The adjustment provisions in Section 104 of the specifications and the retention of funds provisions on Section 109 of the specifications shall not apply to this item.

SECTION 928 GROUND-IN RUMBLE STRIP:

928-1 Description:

The work under this section shall include furnishing all tools, equipment and labor necessary to install ground-in rumble strips of the size and at the locations specified on the project plans or as directed by the Engineer.

928-2 Blank:

928-3 Construction Requirements:

Rumble strips shall be constructed by mechanically milling or grinding grooves into new or existing asphalt or Portland cement concrete pavement. The grooves shall be constructed with a cylindrical or sinusoidal configuration in the direction of the traffic flow and shall be placed in accordance with the details shown on the project plans. Gaps in continuous rumble strips not shown on the plans will be designated by the Engineer.

The grooves shall be constructed with equipment specifically designed to remove such material by means of grinding to a controlled line and grade. The equipment used shall be capable of removing the existing pavement to the dimensions and tolerances specified on the plans. The removals shall be accomplished in a manner which does not scar the surface of the adjacent pavement. Grooves shall not be constructed in new asphaltic concrete pavements for a minimum of three days after placement, or 10 days after placement of new asphaltic concrete pavements with asphalt-rubber, or per the requirements of Subsection 401-3.07 of the specifications for PCCP. Construction of the grooves may be allowed in less time if the contractor can demonstrate that the pavements are sufficiently cured.

The contractor shall place a continuous control line as a guide for installation. The milling machine shall also be equipped with an approved guide that is clearly visible to the operator so that proper alignment of the grooves will be obtained. Lateral deviation of the milled rumble strips shall not exceed 1 inch in any 100 foot interval.

Immediately upon completion of the ground-in rumble strip installation, the pavement and grooves will be cleaned of all milling debris. The contractor shall dispose of the milled material in a manner approved by the Engineer.

928-4 Method of Measurement:

Ground-in rumble strips will be measured by the linear foot along the pavement edge line, at the locations shown in the project plans and in accordance with the specifications. Breaks in the continuous rumble

strip for 10-foot skips, intersections, ramps, and other features will not be included in the measurement.

No measurement will be made for the removal and disposal of milling and debris.

928-5 Basis of Payment:

The accepted quantities of ground-in rumble strips, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the work complete in place as shown on the project plans and as specified herein.

No additional payment will be made for the removal and disposal of milling and debris, the cost being considered as included in the price of the contract item.

SECTION 929 MECHANICALLY STABILIZED EARTH (MSE) WALLS:

929-1 Description:

929-1.01 General:

The work under this section consists of designing, furnishing all materials and constructing Mechanically Stabilized Earth (MSE) retaining walls in accordance with these specifications and in compliance with the lines and grades, dimensions and details shown on the project plans and as directed by the Engineer.

The contractor shall provide the MSE wall designer with a complete set of project plans and specifications and shall ensure that the wall design is compatible with all other project features that can impact the design and construction of the wall.

The terms used in this specification for identification of various entities responsible for MSE Wall designs are defined in Table 929-1:

TABLE 929-1

Term	Entity Responsibilities
Wall Manufacturer/Supplier	The entity contractually retained by the contractor to provide materials and construction support services for an accepted MSE wall system as identified in Subsection 929-1.03 of the specifications.
Wall Designer	The entity contractually retained by the contractor to provide internal design of an accepted MSE wall system as identified in Subsection 929-1.03 of the specifications. The Wall Designer is also responsible for

	evaluating certain aspects of external stability as discussed herein using the geotechnical information provided by the Geotechnical Engineer. The Wall Designer may be a representative of the Wall Manufacturer/Supplier. Internal design includes evaluation of compound stability, which is defined as a failure mode passing through the reinforced soil mass and the retained fill and/or foundation. Geotechnical properties for the retained fill and foundation are to be obtained from the Geotechnical Engineer. The aspects of external stability as discussed below for Geotechnical Engineer that are the responsibility of the Wall Designer to evaluate are as follows: (1) Verify the bearing pressures do not exceed the bearing resistance of the foundation soils shown on the bearing resistance charts provided by the Geotechnical Engineer. (2) Estimate the settlements along the length of the accepted MSE wall system, as identified in Subsection 929-1.03 of the specifications, using the Service I limit state settlement curves shown on the bearing resistance charts provided by the Geotechnical Engineer. (3) Evaluate limited eccentricity and sliding of the accepted MSE wall system, as identified in Subsection 929-1.03, using the geotechnical properties for the retained fill and foundation material provided by the Geotechnical Engineer.
Geotechnical Engineer	The entity responsible to evaluate or provide geotechnical information needed for the Wall Designer to evaluate certain aspects of external stability of the accepted MSE wall system as identified in Subsection 929-1.03 of the specifications. External stability includes the analysis of: (1) Bearing Capacity (2) Settlement (short term and post construction) (3) Limited Eccentricity

	(4) Sliding (5) Global slope stability The bearing capacity and settlement (short term) shall be evaluated by the Geotechnical Engineer and provided to the Wall Designer in the form of a bearing resistance chart developed in accordance with ADOT SF-1 (2010) Memorandum (3). Bearing resistance charts shall be developed for each boring advanced along the length of the proposed MSE walls. Long-term settlements (post construction) shall be evaluated by the Geotechnical Engineer and provided to the Wall Designer so that the Wall Designer can account for such settlements in their design. Geotechnical properties of the retained fill and foundation material shall be provided by the Geotechnical Engineer to the Wall Designer to allow the Wall Designer to evaluate limited eccentricity and sliding of the accepted MSE wall system, as identified in Subsection 929-1.03 of the specifications.

Notes:

(1) For design build (DB)/ CMAR/ P3 projects, both the Wall Designer and Geotechnical Engineer shall be contractually retained by the contractor to provide the responsibilities defined herein.

(2) The geotechnical properties for the retained fill provided by the Geotechnical Engineer to the Wall Designer are minimum properties based on global stability analysis performed by the Geotechnical Engineer, and the Wall Designer may elect to use material exceeding those minimum property values for design. In such case, the geotechnical properties used by the Wall Designer exceeding those provided by the Geotechnical Engineer shall become the required geotechnical properties for the retained fill during construction.

(3) ADOT SF-1 (2010): Development of Factored Bearing Resistance Chart by a Geotechnical Engineer for Use by a Bridge Engineer to Size Spread Footings on Soils for Service and Strength Limit States Based on Load and Resistance Factor Design (LRFD) Methodology, Memorandum from N. H. Wetz and J. D. Wilson to J. Lawson, Dated March 19, 2008 (Revision 1).

929-1.02 Certifications:

(A) Certification of Review of Geotechnical Report(s):

The contractor shall be responsible to review all available geotechnical investigation reports, and the contractor's signature on the proposal form shall certify that this review has been performed and that this specification and any relevant geotechnical information has been provided to the firms designing and supplying the MSE wall.

The geotechnical investigation reports are available on the Contracts and Specifications Section current advertisement website.

(B) Certification of Design Parameters:

See Subsection 929-2.01 of the specifications herein specified.

(C) Certification of Materials:

See Subsections 929-3.04, 929-3.06 and 929-3.09 of the specifications herein specified.

929-1.03 Accepted Systems:

The contractor shall select one of the appropriate ADOT pre-approved earth retaining systems to be constructed for the MSE walls designated on the plans.

Pre-approved systems are listed on the ADOT Bridge Group website:

https://azdot.gov/business/engineering-and-construction/bridge/guidelines/geotech-services/mse-walls-pre-approved

The features of the system(s) furnished, including design and configuration of precast elements, fasteners, connections, soil reinforcements, joint fillers, geotextile filter, and other necessary components shall be those that meet the requirements of Subsection 929-2 of the specifications.

Heights and lengths of earth retaining MSE walls may vary from, but shall not be less than, those shown on the plans. The height and length to be used for any system shall be the minimum for that system that will effectively retain the earth behind the wall for the loading conditions and the contours, profile, or slope lines shown on the plans, in accordance with all relevant internal and external stability design criteria.

929-1.04 Unlisted Systems Acceptance Process:

If the contractor elects to use an earth retaining systems not listed on the ADOT Bridge Group website, the approval process for such systems is as follows:

(1) No consideration will be given to a request for approval of an unlisted system prior to contract award. After award, and in time to allow for consideration without delaying work, the contractor shall submit a written request for approval of a new system.

(2) If the contractor wishes to propose multiple systems, separate written requests shall be submitted for each system. All requests must be received within the timeframes specified herein.

(3) The contractor's progress schedule shall indicate when the proposed system is to be used on the project. The schedule shall include time for the Department to evaluate the proposed system and shall demonstrate that there will be no impacts to the critical path. If, in the opinion of the Engineer, the schedule shows that the evaluation and approval timeframe of the proposed system is not reasonable, the Department will not consider the proposed system.

(4) A request for the use of an unlisted system shall include all information necessary to determine that a system is an equal, including samples for testing, if required. Unlisted systems will not be entertained as Value Engineering (VE) Proposals.

(5) The Department will evaluate the information submitted, perform tests when necessary and make comparisons. The Engineer will then make the final decision as to whether the proposed system is an equal. The Department will neither be liable for any delay in acting upon any request nor for any failure to approve a request pursuant to the use of an unlisted system.

(6) The Department will review the contractor's request for the use of an unlisted system within 45 days of the contractor's submittal and inform the contractor in writing if the request is rejected, approved, or if the Department will take additional time for evaluation. Any additional information needed to evaluate the proposed system shall be submitted in a timely manner. Untimely submittals of additional information shall result in rejection of the proposed system.

(7) The contractor shall not be entitled to additional compensation or an extension of contract time resulting from the Department's acceptance or rejection of a proposed system. Bid prices shall not to be based on the anticipated approval of a proposed system.

929-1.05 Manufacturer's Field Representative:

The manufacturer's field representative performing the work described in this specification shall have, in the past three years, successfully installed at least four MSE retaining walls of heights, lengths and complexity similar to those shown on the plans and meeting the tolerances specified herein. The manufacturer's field representative may make field changes subject to the approval of the Engineer. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer, who is registered as a Civil Engineer in the State of Arizona.

929-1.06 MSE Pre Activity Meeting:

A pre-activity meeting will be scheduled prior to commencement of MSE wall construction activity. As a minimum, this meeting shall be attended by the Engineer, contractor (including wall construction crew chiefs), the MSE wall sub-contractor, MSE wall manufacturer's and MSE Wall designer's representatives. No wall construction activity shall be performed until the contractor's final submittals have been approved as having satisfactorily resolved all review comments and the pre-activity meeting has been held.

929-1.07 Wall Aesthetics:

Wall aesthetics shall be as specified in the project plans and Special Provisions.

929-2 Submittals (Working Drawings and Design):

929-2.01 Submittals:

The submittals required shall include working drawings, construction procedures, supporting design calculations, verification of experience, and a transmittal letter. The transmittal letter shall only list the documents included in the submittal. No technical information shall be included in the transmittal letter.

Working drawings and calculations shall be signed and sealed by a Professional Engineer, who is registered as a Civil Engineer in the State of Arizona. The MSE wall designer/supplier shall document on the working drawings all assumptions made in the design. The following statement shall be included near the P.E. seal on the first sheet of the working drawings: "All design assumptions are validated through notes or details on these drawings".

Working drawings, design calculations, and MSE wall supplier's construction procedures modified as necessary by the contractor and wall designer for site-specific conditions shall be submitted to the Engineer for review. The Engineer shall have 15 calendar days after receiving the submittal to finish a review. The revised package shall be resubmitted to the Engineer for review. The Engineer shall have 5

calendar days to complete this review. This review process shall be repeated until the entire submittal is accepted by the Engineer.

The Department assumes no responsibility for errors or omissions in the working drawings. Acceptance of the final working drawings submitted by the contractor shall not relieve the contractor of any responsibility under the contract for the successful completion of the work.

Construction of the wall shall not commence until the contractor receives a written Notification to Proceed (NTP) from the Engineer. The NTP will be issued once the complete wall package (drawings, calculations, and construction procedures) is accepted. Fabrication of any of the wall components before the NTP shall be at the sole risk of the contractor.

929-2.02 Working Drawings:

The contractor shall submit complete working drawings and specifications for each installation of the system in accordance with the requirements of Subsection 105.03 of the specifications as modified herein.

Working drawings shall include the following at a minimum:

(1) Layout of the wall including plan and elevation views;

(2) All design parameters and assumptions including design life;

(3) Existing ground elevations and utilities impacted by the wall shall be field verified by the contractor for each location;

(4) Complete details of all elements and component parts required for the proper construction of the system at each location and any required accommodations for drainage systems, foundation subgrades or other facilities shown on the contract documents;

(5) The working drawing submittal shall clearly detail any special design requirements. These special design requirements may include, but are not limited to; structural frames to place reinforcements around obstructions such as deep foundations and storm drain crossings, drainage systems within the reinforced backfill, placement sequence of drainage and unit core fill with respect to reinforced (structure) fill behind a wall face using modular block facing units, guardrail post installation, scour protection, foundation subgrade modification, all corner details (acute, obtuse and 90 degrees), slip joints, connection details of MSE walls with other cast-in-place structures, wedges, shims and other devices such as clamps and bracing to establish and maintain vertical and horizontal wall facing alignments;

(6) A complete listing of components and materials specifications; and

(7) Other site-specific or project specific information required by the contract.

929-2.03 MSE Wall Design:

(A) General:

The working drawings shall be supplemented with all design calculations for the particular installation as required herein.

The proposed design shall satisfy the design parameters shown on the project plans and listed in these specifications, and comply with the design requirements of the following documents:

- FHWA (2009), "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes; Publication No. FHWA-NHI-10-024 and FHWA-NHI-10-025; Authors: Berg, R. R., Christopher, B. R., and Samtani, N. C.

- AASHTO (2017), "AASHTO LRFD Bridge Design Specifications", 8th Edition, including latest Interims.

All references made to AASHTO (2017) herein shall mean "AASHTO LRFD Bridge Design Specifications", 8th Edition, including latest Interims.

Maximum reinforcement loads shall be calculated using the "Simplified Method" as presented in AASHTO (2017) and as per the requirements specified herein. No other design method will be allowed.

Sample analyses and hand-calculations shall be submitted, if requested by the Engineer, to verify the output from software used by the MSE wall designer. Sample analyses and hand calculations shall be required for complex walls having geometries and loading conditions that are not readily amenable to computer analysis. Failure modes, including circular, non-circular, and multi-part wedge shall be analyzed for compound stability to verify the most critical failure case (slip surface with lowest factor of safety) within each section of the wall where the length of the reinforcement changes. For compound stability, all potential slip surfaces for each failure mode passing through all Three Search Zones as specified in the Special Provisions shall be analyzed to determine the most critical failure case. Each failure mode shall be analyzed individually and not be forced to mimic the results of other failure modes. The compound stability analyses are required for all wall geometries including walls with level ground in front of wall and level backfill behind wall. Global stability requirements are contained in the MSE wall design summary plan sheet.

The contractor and wall designer shall identify the specific locations on working drawing plan and profiles based on subgrade evaluation and at other key locations to control the deformation along the wall. The soil reinforcement attached to the slip joints shall be oriented perpendicular to the slip joint panels and shall be the full design length. Special connection and compaction details shall be provided on the working drawings.

At all corners formed by two MSE walls, the leveling pad along the shorter wall forming the corner shall be at the same elevation as the leveling pad for the taller wall for a distance of at least 80 percent of the height of the taller wall or a distance of 10 feet, whichever is greater.

Unless otherwise specified in the contract, all structures shall be designed to conform to the requirements shown in Table 929-2 and other requirements specified herein.

TABLE 929-2

DESIGN PARAMETERS

Description	Limit State	Value	Note
1. Design Life	All limit states	75 Years	
2. Effective (Drained) Friction Angle			
a. Retained Backfill	All limit states	(Project specific as detailed in the MSE wall design summary sheet)	1
b. Reinforced Backfill	All limit states	34°, 110 pcf	1
3. Length of Soil Reinforcement, B	All limit states	0.7H min or 8-ft whichever is more	2
4. Limiting Eccentricity	Strength (all)	B/3 (soil), 0.45B (rock)	
	Service I	B/6 (soil), B/4 (rock)	
5. Coefficient of Sliding Friction	Strength (all)	tan[min(ϕr, ϕf, ϕi)]	3
6. Resistance Factors			
a. Sliding	Strength (all)	1.0	4
b. Bearing	Strength (all)	0.65	5
c. Overall (Slope) Stability			
I. Deep Seated Stability	Service I	0.65	6
II. Compound Stability	Service I	0.65	6
d. Pullout Resistance			
I. Static	Strength (all)	0.90	7

II. Combined Static/Earthquake	Strength (all)	1.20	7
e. Tensile Resistance of Metallic Reinforcements and Connectors			
I. Static - Strip Reinforcement - Grid Reinforcement	 Strength (all) Strength (all)	 0.75 0.65	 8 8,9
II. Combined Static/Earthquake - Strip Reinforcement - Grid Reinforcement	 Strength (all) Strength (all)	 1.00 0.85	 8 8,9
f. Tensile Resistance of Geosynthetic Reinforcements and Connectors			
III. Static	Strength (all)	0.90	
IV. Combined Static/Earthquake	Strength (all)	1.20	

Notes:

1) Retained backfill requirements shall be project specific as noted on the MSE wall summary plan sheet developed by the Geotechnical Engineer.
2) H is the design height of the wall and is defined as the difference in elevation between the finished grade at top of wall and the top of leveling pad. The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for that location. The length of the soil reinforcement, B, is measured from the backface of the wall facing unit. In case of grid type reinforcements the length of the soil reinforcement is measured from the backface of the wall to the last full transverse member. For modular block facing units, the total length of the reinforcement, BT, as measured from the front face of the wall is the length B as defined above plus the width of the modular block unit (the horizontal dimension of the block unit measured perpendicular to the wall face). Depending on the configuration of the reinforcements and properties of the various actual fills selected by the contractor, the minimum length of the reinforcement may need to be increased to satisfy the required resistance factors for compound stability analyses.
3) ϕr= friction angle of reinforced wall fill.
   ϕf = friction angle of foundation soil (As reported on the MSE wall design summary plan sheet).
   ϕI = friction angle of the interface between reinforcement and soil for cases of sheet reinforcement such as geotextiles.

All friction angles are effective (drained) friction angles. Refer to the MSE wall design summary plan sheet for friction angle and unit weight of foundation soil.

4) Passive resistance shall not be considered in evaluation of sliding resistance.
5) For all limit states, the design loading for the MSE retaining wall system shall not exceed the factored general and local bearing resistances specified in the Geotechnical Report(s).
6) For earthquake loading condition, a resistance factor of 0.90 shall be used.
7) Live load due to vehicular traffic shall be included in the computations to determine the maximum tensile forces in reinforcement layers, but shall be neglected in the computations for pullout resistance. Intensity of live load shall be considered as a uniform surcharge using the equivalent height of soil in accordance with Section Article 3.11.6.4 of AASHTO (2017).
8) Apply to gross cross-section less sacrificial area. For sections with holes, reduce gross area in accordance with Article 6.8.3 of AASHTO (2017) and apply to net section less sacrificial area.
9) Applies to grid reinforcements connected to a rigid facing element, e.g., a concrete panel or block. For grid reinforcements connected to a flexible facing mat or which are continuous with the facing mat, use the resistance factor for strip reinforcements.
10) Unless otherwise specified, all resistance factors shall be taken as 1.0 when investigating an extreme event limit state.

(B) Subsurface Drainage Systems:

Walls shall be provided with subsurface drainage measures as shown on the project plans and specifications. As a minimum, an underdrain system shall be provided for leading subsurface and surface water away from the backfill and outside the limits of the wall. Geocomposite drains, if used for subsurface drainage, shall be in accordance with Subsection 203-5.02 and 203-5.03(C) of the specifications.

The Wall Designer is responsible for drainage measures within the reinforced backfill. Drainage measures outside the MSE wall backfill shall be designed by the project civil designer.

(C) Obstructions in Backfill:

(1) General:

Where obstructions, such as deep foundations or storm drains crossings, are located in the reinforced backfill zone, cutting of reinforcements to avoid obstructions shall not be permitted. A minimum offset of one diameter but not less than 3 feet shall be maintained between the face of any pipe crossings and the back face of MSE retaining wall panels. A

minimum clearance of 3 feet shall be maintained between the face of any other obstruction and the back face of MSE retaining wall panels.

(2) Horizontal Deflection of Reinforcements:

In the horizontal plane at a reinforcing level, a deviation up to 15 degrees from normal to the face of the wall may be allowed for strip reinforcement and bolted connection. This deviation is herein referred to as the splay angle. Grid reinforcements may not be splayed, unless connection has been specifically fabricated to accommodate a splay and connection detail has been approved by the Department. If used, the splay in grid reinforcements is limited to five degrees. For obstructions that cannot be accommodated with splayed reinforcement, structural frames and connections shall be required, and shall be designed in accordance with Section 10 ("Steel Structures") of AASHTO (2017) for the maximum tension in the reinforcements. The structural frame design shall be such that bending moments are not generated in the soil reinforcement or the connection at the wall face. The design, along with supporting calculations, shall be included in the working drawings.

(3) Vertical Deflection of Reinforcements:

Vertical deflection of the reinforcement to avoid obstructions such as utilities along the wall face shall be limited to a maximum of 15 degrees from normal to face of wall. Bends in the reinforcement shall be smooth and gradual to ensure that galvanization remains intact.

(D) Hydrostatic Pressures:

As determined by the Engineer and/or as noted on the plans, for walls potentially subject to inundation, such as those located adjacent to rivers, canals, detention basins or retention basins, a minimum hydrostatic pressure equal to three feet shall be applied at the high-water level for the design flood event. Effective unit weights shall be used in the calculations for internal and external stability beginning at levels just below the equivalent surface of the pressure head line. Where the wall is influenced by water fluctuations, the wall shall be designed for rapid drawdown conditions which could result in differential hydrostatic pressure greater than 3 feet. As an alternative to designing for rapid drawdown conditions, Size 57 coarse aggregate, as specified in AASHTO M 43, shall be provided as reinforced backfill for the full length of the wall and to the maximum height of submergence of the wall. Separation fabric shall be class I needle-punched polypropylene non-woven geotextile with the highest permittivity shown in AASHTO M 288. The fabric shall be provided at the interface of the Size 57 coarse aggregate and reinforced backfill above it, and at the interface of the retained backfill behind it. Adjoining sections of separation fabric shall be overlapped by a minimum of 12 inches.

(E) Acute Angle Corners:

Wall corners with an included angle of less than 70 degrees shall be designed for bin-type lateral pressures for the extent of the wall where the full length of the reinforcement cannot be installed without encountering a wall face. Acute angle corner structures shall not be stand-alone separate structures. Computations shall be provided that demonstrate deformation compatibility between the acute angle corner structure and the rest of the MSE wall. Full-height vertical slip joints shall be provided at the acute angle corner and after the last column of panels where full length of the reinforcements can be placed. The soil reinforcement attached to the slip joints shall be oriented perpendicular to the slip joint panels and shall be the full design length. Special connection and compaction details shall be provided on the working drawings.

(F) Slip Joints:

For walls with precast concrete panels, vertical slip joints shall be included in the wall face at the following locations and as shown on the plans, whichever is more stringent:

(1) Boundaries of limits where differential settlement exceeds 1/100.

(2) All locations where a wall height changes by more than five feet.

(3) All corners within an MSE wall.

(4) Each side of a stiff element such as a reinforced concrete box culvert (RCBC), abutment wing walls, or any other wall face penetration larger than 5 feet.

(5) Each side of a drilled shaft foundation constructed prior to and within 8 feet of the face of wall. Approximate locations of slip joints are shown on the project plans.

(G) Spacing of Metallic Reinforcement for Flexible Face Wall Systems:

For permanent walls, vertical and horizontal spacing of metallic reinforcements for flexible face (welded wire or similar) wall systems shall not exceed 18 inches. The stiffness of the facing and spacing of reinforcements shall be such that the maximum local deformation between soil reinforcement layers shall be limited to less than 1-1/2 inches. Facing elements shall not yield in bending and tension.

For temporary walls, i.e., walls with less than 36 months service life, the contractor may adjust the stiffness of the facing and spacing of the reinforcements such that the local deformation between the reinforcement is within the elastic range in bending and tension, and the

overall geometry meets the line and grade requirements for the temporary walls.

(H) Soil Reinforcement for Modular Block Wall (MBW) Systems:

The soil reinforcement lengths and percent coverage at a given reinforcement level shall be in accordance with the plans. All soil reinforcement shall be positively connected to the modular block facing units by a connection that is capable of resisting 100 percent of the maximum tension in the soil reinforcements at any level within the wall. Detailed documentation for connection strength shall be submitted as noted in Subsection 929-3.09 of the specifications. The vertical spacing of the soil reinforcement for walls with modular block facing units shall be as follows:

(1) The first (bottom) layer of soil reinforcement shall be no further than 16 inches above the top of the leveling pad.

(2) The last (top) layer of soil reinforcement shall be no further than 20 inches on the average below the top of the uppermost MBW unit.

(3) The maximum vertical spacing between layers of adjacent soil reinforcement shall not exceed 24 inches. For walls deriving any part of their connection capacity by friction the maximum vertical spacing of the reinforcement shall be limited to two times the block depth (front face to back face) to assure construction and long-term stability. The top row of reinforcement shall be placed at a depth no more than two times the block height from the top of finished grade.

(I) Initial Batter of Wall:

The initial batter of the wall, both during construction and upon completion, shall be within the vertical and horizontal alignment tolerances included in this specification. The initial batter of the wall at the start of construction and the means and methods necessary to achieve the batter shall be provided on the working drawings. Subject to Engineer's approval, the initial batter may be modified at the start of construction by the manufacturer's field representative based on the evaluation of the backfill material selected by the contractor. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer who is registered as a Civil Engineer in the State of Arizona. Details of the wedges or shims or other devices, such as clamps and external bracing used to achieve or maintain the wall batter, shall be as shown on the working drawings and/or accompanying construction manual. Permanent shims shall comply with the design life criteria, and shall maintain the design stress levels required for the walls.

929-3 Material Requirements:

929-3.01 Precast Concrete Elements:

Precast concrete elements shall conform to the requirements for precast minor structures in Sections 601 and 1006 of the specifications. The concrete shall be Class S with minimum design strength of 4,000 pounds per square inch. The mix design shall conform to the requirements of Subsection 1006-3 of the specifications.

Prior to casting, all embedded components shall be set in place to the dimensions and tolerances designated in the plans and specifications. Rustication for wall aesthetics shall be in accordance with project plans, special provisions, and applicable requirements of Sections 601, 610, 1002 and 1006 of the specifications.

(A) Concrete Testing and Inspection:

Precast concrete elements shall be subjected to compressive strength testing in accordance with Subsection 1006-7 of the specifications, and inspected for surface conditions and dimensional tolerances in accordance with Subsections 601-3.05 and 601-4.02 of the specifications respectively. Panels delivered to the site without the ADOT acceptance stamp will be rejected.

(B) Casting:

Precast concrete face panels shall be cast on a horizontal surface with the front face of the panel at the bottom of the form. Connection hardware shall be set in the rear face. The concrete in each precast concrete panel shall be placed without interruption and shall be consolidated by deploying an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corner of the forms, and to eliminate the formation of stone pockets or cleavage planes. Form release agents as specified in Subsection 601-3.02(C)(1) of the specifications shall be used on all form faces for all casting operations.

The contractor shall advise the Engineer of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State of Arizona, or 21 calendar days if the casting operation is outside the State of Arizona.

(C) Finish:

(1) Non-Exposed Surfaces:

Rear faces of precast concrete panels shall receive a Class I finish in accordance with Subsection 601-3.05 of the specifications.

(2) Exposed Surfaces:

The type of finish required on exposed surfaces shall be as shown in the plans.

(a) Exposed Aggregate Finish:

(i) Prior to placing concrete, a set retardant shall be applied to the casting forms in accordance with the manufacturer's instructions.

(ii) After removal from the forms and after the concrete has set sufficiently to prevent its dislodging, the aggregate shall be exposed by a combination of brushing and washing with clear water. The depth of exposure shall be between 3/8 inch and 1/2 inch.

(iii) An acrylic resin sealer consisting of 80 percent thinner and 20 percent acrylic solids by weight shall be applied to the exposed aggregate surface at a rate of 1 gallon per 250 square feet.

(b) Concrete Panel Finish:

Concrete panel finish shall be in accordance with Subsection 601-3.05 of the specifications.

(D) Tolerances:

Precast concrete elements shall comply with Subsection 601-4.02(B)(1) and 601-4.02(B)(4) of the specifications. Connection device placement shall be within ± 3/8 inch of the dimensions shown on the drawings. Panel squareness as determined by the difference between the two diagonals shall not exceed 1/2 inch.

(E) Identification and Markings:

The date of manufacture, the production lot number, and the piece mark shall be inscribed on a non-exposed surface of each element.

(F) Handling, Storage, and Shipping:

All panels shall be handled, stored, and shipped in such a manner to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported in firm blocking to protect panel connection devices and the exposed exterior finish. Storing and shipping shall be in accordance with the manufacturer's recommendations.

(G) Compressive Strength:

Precast concrete elements shall not be shipped or placed in the wall until a compressive strength of 3,400 pounds per square inch has been attained. The facing elements shall be cast on a flat and level area and shall be fully supported until a compressive strength of 1,000 pounds per square inch has been attained.

(H) Precast Concrete Panel Joints:

(1) General:

Where the wall wraps around an inside corner, a corner block panel shall be provided with flange extensions that will allow for differential movement without exposing the panel joints. The back face of vertical and horizontal joints shall be covered with geotextile filter. Joint filler, bearing pads, and geotextile filter shall be as recommended by the wall manufacturer and shall meet the requirements shown on the approved working drawings.

If required, as indicated on the plans, flexible open-cell polyurethane foam strips shall be used for filler for vertical joints between panels, and in horizontal joints where pads are used.

All joints between panels on the back side of the wall shall be covered with a geotextile meeting the requirements for filtration applications as specified by AASHTO M 288. The minimum width shall be foot.

(2) Bearing Pads:

All horizontal and diagonal joints between panels shall include bearing pads. Bearing pads shall meet or exceed the following material requirements:

(a) Preformed EPDM (Ethylene Propylene Diene Monomer) rubber pads conforming to ASTM D2000 Grade 2, Type A, Class A with a Durometer Hardness of 70.

(b) Preformed HDPE (High Density Polyethylene) pads with a minimum density of 0.946 grams per cubic centimeter in accordance with ASTM D1505.

The stiffness (axial and lateral), size, and number of bearing pads shall be determined such that the final joint opening shall be 3/4 inches within -1/8 inch unless otherwise shown on the plans. The MSE wall designer shall submit substantiating calculations verifying the stiffness (axial and lateral), size, and number of bearing pads assuming, as a minimum, a vertical loading at a given joint equal to 2.5 times the weight of facing panels directly above that level. As part of the substantiating calculations, the MSE wall designer shall submit results of certified

laboratory tests in the form of vertical load-vertical strain and vertical load-lateral strain curves for the specific bearing pads proposed by the MSE wall designer. The vertical load-vertical strain curve shall extend beyond the first yield point of the proposed bearing pad.

929-3.02 Steel Components:

Steel components shall conform to the applicable requirements of Sections 605 and 1003 of the specifications.

(A) Galvanization:

Soil reinforcement steel shall be hot-dip galvanized in accordance with AASHTO M 111 (ASTM A123). Connection hardware steel can be galvanized by hot-dipping or other means, provided the method satisfies the requirements of AASHTO M 111 (ASTM A123). A minimum galvanization coating of 2.0 oz./ft^2 (605 g/m^2) or 3.4 mils (85 µm) thickness is required. Soil reinforcement steel shall be adequately supported while lifting and placing such that the galvanization remains intact. Steel members with damaged (peeled) galvanization shall be repaired according to ASTM A780 and as specified in approved working drawings, at no additional cost to the Department.

(B) Metallic Reinforcing Strips and Tie Strips:

Reinforcing strips shall be hot-rolled from bars to the required shape and dimensions. The strips' physical and mechanical properties shall conform to the requirements of ASTM A572, Grade 65 minimum.

Tie strips shall be shop fabricated of hot-rolled steel conforming to the requirements of ASTM A1101, Grade 50 minimum. The minimum bending radius of the tie strips shall be 3/8 inch. Galvanization shall be applied after the strips are fabricated, inclusive of punch holes for bolts as shown on approved drawings.

(C) Metallic Reinforcing Mesh:

Reinforcing mesh shall be shop fabricated of cold-drawn steel wire conforming to the requirements of AASHTO M 32, and shall be welded into the finished mesh fabric in accordance with AASHTO M 55. Galvanization shall be applied after the mesh is fabricated. A minimum galvanization coating of 2.0 oz./ft^2 (605 g/m^2) or 3.4 mils (85 µm) thickness is required.

(D) Connector Pins:

Connector pins and mat bars shall be fabricated and connected to the soil reinforcement mats as shown in the approved working drawings. Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32.

(E) Welded Wire Fabric:

All welded wire fabric shall conform to the requirements of AASHTO M 32, AASHTO M 55, and the approved working drawings. Welded wire fabric shall be galvanized in conformance with the requirements of ASTM A123.

(F) Fasteners:

Connection hardware shall conform to the requirements shown in the approved working drawings. Connection hardware shall be cast in the precast concrete panels such that all connectors are in alignment and able to transfer full and even load to the soil reinforcement. Once the reinforcement is connected to the panel, the amount of slack shall not exceed 1/8 inch between the connector and the reinforcement during field installation. Fasteners shall be galvanized and conform to the requirements of AASHTO M 164 or equivalent.

929-3.03 Geosynthetic Reinforcement:

Geosynthetic soil reinforcement shall be limited to geosynthetics manufactured from polypropylene, high density polyethylene, and polyester. Geosynthetic reinforcement shall be evaluated through the AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) REGEO (AASHTO Product Evaluation & Audit Solutions – Geosynthetic Reinforcements) for installation damage reduction factor RF_{ID} and creep reduction factor RF_{CR}. The geogrid shall be a regular network of integrally connected polymer tensile elements, with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil. Geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport, and installation. Geosynthetic reinforcements other than geogrids may be utilized if an independent evaluation has been performed through AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) REGEO.

The nominal long-term tensile design strength (T-AL) of specific geosynthetic material shall meet or exceed the creep and durability reduction factors required by the wall manufacturer, as well as those required by AASHTO (2017). The wall designer may not select installation damage reduction factor RF_{ID} and creep reduction factor RF_{CR} to be less than the results obtained through the AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) REGEO program.

929-3.04 Certificate of Analysis for Soil Reinforcements:

The contractor shall furnish the Engineer with a Certificate of Analysis conforming to the requirements of Subsection 106.05 of the specifications for all materials.

For geosynthetics, the Certificate of Analysis shall verify that the supplied geosynthetic is the type approved by the Engineer and as

measured in full accordance with all test methods and standards specified herein. The manufacturer's certificate shall state that the furnished geosynthetics meet the requirements of the specifications, as evaluated by the AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) REGEO program.

For metallic wall reinforcement, a mill test report containing the ultimate tensile strength for the soil reinforcement shall be included in the certification. For metallic wall reinforcement, a mill test report containing the galvanization coverage shall be included in the certification. For metallic mesh wall reinforcement, a mill test report containing the ultimate weld strength for the soil reinforcement shall be included in the certification.

929-3.05 Reinforced and Retained Backfill Material:

(A) General:

Reinforced backfill material shall be free of shale, organic matter, mica, gypsum, smectite, montmorillonite, or other soft poor durability particles. No salvaged material, such as asphaltic concrete millings or Portland Cement Concrete rubble, etc., will be allowed.

Retained backfill material shall be project specific as noted on the MSE wall summary plan sheet developed by the Geotechnical Engineer.

(B) Soundness:

The reinforced backfill material shall have a soundness loss of 30 percent or less when tested in accordance with AASHTO T 104 using a magnesium sulfate solution with test duration of four cycles. Alternatively, the material shall have a soundness loss of 15 percent or less when tested in accordance with AASHTO T 104 using a sodium sulfate solution with test duration of five cycles. Aggregate sources with recent testing data within the past year may submit previous testing results for soundness determination.

(C) Gradation and Fractured Coarse Aggregates:

Gradations will be determined by AASHTO T 11 and AASHTO T 27 and shall be in accordance with Table 929-3, unless otherwise specified.

Material retained on the #4 and larger sieves must have a minimum of 50 percent particles with two or more mechanically induced crushed faces when tested by AASHTO T 335.

TABLE 929-3	
BACKFILL GRADATION REQUIREMENTS	
Sieve Size	**Percent Passing**
1-1/2 inch	100

1 inch	95-100
1/2 inch	25-60
No. 4	0-10
No. 8	0-5

(D) Separation Fabric:

A Class I needle-punched polypropylene non-woven separation geotextile fabric, meeting the minimum requirements for filtration applications specified in AASHTO M 288 and Subsection 1014-4 shall encapsulate the rock backfill. Adjoining sections of separation fabric shall be overlapped by a minimum of 12 inches.

(E) Limits of Reinforced Backfill:

For all walls, except back-to-back walls, the reinforced backfill shall extend to at least two feet beyond the free end of the reinforcement. For back-to-back walls wherein the free ends of the reinforcement of the two walls are spaced apart less than or equal to one-half the design height of the taller wall, reinforced wall fill shall be used for the space between the free ends of the reinforcements as well. The design height of the wall is defined as the difference in elevation between the top of coping and the top of leveling pad. The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for the location under consideration.

929-3.06 Certificate of Analysis for Reinforced Backfill Materials:

At least three weeks prior to construction of the MSE wall, the contractor shall furnish the Engineer with an 80 pound representative sample of the reinforced backfill material, and a Certificate of Analysis conforming to the requirements of Subsection 106.05 certifying that the reinforced backfill material comply with the requirements specified herein. During construction, the reinforced backfill material shall be sampled and tested by the contractor for acceptance and quality control testing in accordance with the requirements stated in Table 929-4. A new sample and Certificate of Analysis shall be provided any time the reinforced backfill material changes as noted in Table 929-4.

TABLE 929-4

Sampling Frequency for Reinforced Backfill Material

Test	Frequency
Gradation (AASHTO T 11, T 27)	One per 500 CY at production facility
Plasticity Index (AASHTO T 90)	
Fractured Coarse Aggregate Particles (AASHTO T 335)	

929-3.07 Cast-in-Place Concrete:

Cast-in-place concrete shall conform to the requirements of Sections 601 and 1006. Unless otherwise approved, all cast-in-place concrete shall be Class S with a minimum compressive strength of 4,000 pounds per square inch.

929-3.08 Modular Block (Segmental) Facing Units:

This section covers dry cast hollow and solid wet cast concrete masonry structural retaining wall units, machine made from Portland cement, water, and suitable mineral aggregates. The units are intended for use as facing units in the construction of mortarless, modular block walls (MBW) also known as segmental retaining walls (SRW). Metallic or geosynthetic reinforcement specified in Section 929-3.02 and 929-3.03 of the specifications, respectively, may be used as soil reinforcement in the reinforced (structure) backfill zone.

(A) Casting:

Cementitious material in the modular block facing unit shall be Portland cement conforming to the requirements of ASTM C150. If fly ash is used it shall not exceed 20 percent by weight of the total cement content, and shall conform to ASTM C618. Aggregates used in concrete blocks shall conform to ASTM C33 for normal weight concrete aggregate. Efflorescence control agent shall be used in concrete mix design to prevent efflorescence on the block.

The contractor shall advise the Engineer of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State of Arizona, or 21 calendar days if the casting operation is outside the State of Arizona.

(B) Physical Requirements:

At the time of delivery to the work site, the modular block facing units shall conform to the following physical requirements:

(1) Minimum required compressive strength of 4,000 psi (average 3 coupons)

(2) Minimum required compressive strength of 3,500 psi (individual coupon)

(3) Minimum oven dry unit weight of 125 pcf

(4) Maximum water absorption of 5 percent after 24 hours

(5) Maximum number of blocks per lot of 2,000. Tests on blocks shall be submitted at the frequency of one set per lot.

Acceptance of the concrete block, with respect to compressive strength, water absorption and unit weight, will be determined on a lot basis. The lot shall be randomly sampled and tested in accordance with ASTM C140. As no additional expense to the Department, the manufacturer shall perform the tests at an ADOT approved laboratory and submit the results to the Engineer for approval. Compressive strength test specimens shall be cored or shall conform to the saw-cut coupon provisions of ASTM C140. Block lots represented by test coupons that do not reach an average compressive strength of 4,000 psi will be rejected.

(C) Freeze-Thaw Durability:

In areas above 3,000 feet, where repeated freezing and thawing under saturated conditions occur, the units shall be tested to demonstrate freeze-thaw durability in accordance with Test Method ASTM C1262. Freeze-thaw durability shall be based on tests from five specimens made with the same materials, concrete mix design, manufacturing process, and curing method, conducted not more than 18 months prior to delivery. Specimens used for absorption testing shall not subsequently be used for freeze-thaw testing. Specimens shall comply with either or both of the following acceptance criteria depending on the severity of the project location as determined by the Department:

(1) The weight loss of four out of five specimens at the conclusion of 150 cycles shall not exceed 1 percent of its initial weight when tested in water.

(2) The weight loss of each of four out of the five test specimens at the conclusion of 50 cycles shall not exceed 1.5 percent of its initial mass when tested in a saline (3 percent sodium chloride by weight) solution.

(D) Tolerances for Modular Block Dimensions:

Modular blocks shall be manufactured within the following tolerances:

(1) The length and width of each individual block shall be within ± 1/8 inch of the specified dimension. Hollow units shall have a minimum wall thickness of 1-1/4 inches.

(2) The height of each individual block shall be within ± 1/16 inch of the specified dimension.

(3) When a broken (split) face finish is required, the dimension of the front face shall be within ± 1.0 inch of the theoretical dimension of the unit.

(E) Finish and Appearance:

Units that indicate imperfect molding, honeycomb or open texture concrete and color variation on front face of block due to excess form oil or other reasons shall be rejected. All units shall be visually efflorescence free. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Minor cracks (e.g. no greater than 1/50 inch in width and no longer than 25 percent of the unit height) incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery, are not grounds for rejection.

The exposed faces shall be free of chips, cracks or other imperfections when viewed from a distance of 30 feet under diffused lighting. Up to 5 percent of a shipment may contain slight cracks or small chips not larger than 1.0 inch.

Color and finish shall be as shown on the plans and shall be erected with a running bond configuration.

(F) Pins:

If pins are required to align modular block facing units, they shall consist of a non-degrading polymer or hot-dipped galvanized steel and be made for the express use with the modular block units supplied. Connecting pins shall be capable of holding the geogrid in the proper design position during backfilling.

(G) Cap Units and Adhesive:

The cap unit connection to the block unit immediately under it shall be of a positive interlocking type and not frictional. Cap units shall be cast to or attached to the top of modular block facing units in strict accordance with the requirements of the manufacturer of the blocks and the adhesive. The surface of the block units under the cap units shall be clear of all debris and standing water before the approved adhesive is placed. The contractor shall provide the owner in writing an acceptable 10-year warranty that the integrity of the materials used to attach the cap blocks will preclude separation and displacement of the cap blocks for the warranty period.

(H) Unit (Core) Fill:

Unit (core) fill is defined as free draining, coarse grained material that is placed within the empty cores of the modular block facing units. Unit (core) fill shall be a crushed stone or granular fill.

929-3.09 Certificate of Analysis for Modular Block Connection:

For modular block facing units, a certification shall be provided with detailed calculations according to AASHTO (2017) and the results of

laboratory test results performed in accordance with Section A.3 in Appendix A of FHWA NHI-00-043, dated March 2001 ("Mechanically Stabilized Earth Walls and Reinforced Soil Slopes"). Such certification shall demonstrate that all connections, including block-to-reinforcement and block-to-block connections, and all related components meet or exceed the current AASHTO 75 year design life requirements and are capable of resisting 100 percent of the maximum tension in the soil reinforcements at any level within the wall. Long-term connection testing for extensible reinforcements is also required. The effect of wall batter and normal pressures representative of the full range of wall configurations and heights shall be incorporated in the tests.

929-4 Construction Requirements:

929-4.01 Excavation:

The contractor shall ensure that temporary slopes are safe during the period of wall construction, and shall adhere to all applicable local, state, and federal regulations. During construction of the MSE walls, the contractor shall design, construct, maintain, and when called for, remove temporary excavation support systems (shoring). Temporary excavation support systems may be left in place if approved by the Engineer. The back slope of the excavation shall be benched. Where shoring is required, the contractor shall submit to the Engineer the shoring design, and a plan outlining construction and removal procedures for review and approval prior to proceeding with the work. Shoring plans shall be prepared and submitted as part of the working drawings, as specified in Subsection 105.03 of the specifications, and shall bear the seal and signature of a licensed Professional Civil or Structural Engineer, registered in the State of Arizona. All shoring design shall include appropriate input and review by the contractor's Professional Engineer.

929-4.02 Foundation Preparation:

(A) General:

In the absence of specific ground improvement requirements in the plans and Special Provisions, the following applies:

The foundation for the reinforced and retained wall fill shall be graded level for the entire area of the base of such backfills, plus an additional 12 inches on all sides, or to the limits shown in the plans.

If soil reinforcement components are to be positioned on native soil, the top one foot of native soil shall meet the requirements of the reinforced backfill material specified in Subsection 929-3.05 of the specifications.

If soil reinforcement components are to be positioned on native rock mass, the rock mass shall be classified as at least Class II rock mass in

accordance with Subsection 10.4.6.4 of AASHTO LRFD Bridge Design Specifications, 6th edition (2012).

(B) Proof-Rolling:

Proof-rolling shall be performed to evaluate the stability and uniformity of the subgrades on which retaining wall structures will be constructed. Proof-rolling shall be performed on the entire areas at the following locations and at other locations shown on the project plans:

(1) At the bottom of the overexcavation and recompaction zones if specified;

(2) At the bottom of the overexcavation and replacement zones if specified;

(3) At the base of all retaining walls;

(4) At the base of all concrete box culverts;

(5) At the top of native soil layers that have been scarified, moisture conditioned and recompacted (if different from the bottom of the overexcavation and recompaction or overexcavation and replacement zones).

The proof-rolling shall be done immediately after subgrade compaction while the moisture content of the subgrade soil is near optimum or at the moisture content that achieved the required compaction.

If proof-rolling is performed after installation of pipe underdrains, do not use the proof-roller within 1.5 feet of the underdrains. Proof-rolling shall be performed with a pneumatic tired tandem axle roller with at least three wheels on each axle, a gross weight of 25 tons (50 kips) (This weight shall be determined on a project by project basis, depending on the soils and purpose of the proof-rolling), a minimum tire pressure of 75 psi and a minimum rolling width of 75 inches. A Caterpillar PS-300B (or PF-300B), Ingersoll-Rand PT-240R, BOMAG BW24R, Dynapac CP271 or equipment with equivalent capabilities shall be used for proof-rolling. The use of water trucks, scrapers, or other equipment for proof-rolling of the subgrades is not allowed.

Proof-rolling equipment shall be operated at a speed between 1.5 to 3 miles per hour or slower as required by the Engineer to permit measurements of ruts and/or pumping deformations.

Proof-rolling shall be carried out in two directions at right angles to each ther with no more than 24 inches between tire tracks of adjacent passes. In cases where proof-rolling perpendicular to the wall alignment is not possible due to space constraints, proof-rolling shall be performed parallel to the wall with minimum 6-inches overlap between the tracks of adjacent passes. The contractor shall operate the proof-roller in a

pattern that readily allows for the recording of deformation data and complete coverage of the subgrade.

The following actions shall be taken based on the results of the proof-rolling activity:

If rutting is less than 1/4 inch; the grade is acceptable.

If rutting is greater than 1/4 inch and less than 1-1/2 inches; the grade needs to be scarified and re-compacted.

If rutting is greater than 1-1/2 inches; the compacted area shall be removed and reconstructed.

If pumping (deformation which rebounds or materials are squeezed out of wheel's path) is greater than one inch; remediate as directed by the Engineer.

The contractor is responsible for maintaining the condition of the approved proof-rolled soils throughout the duration of the retaining MSE wall construction. Wall construction shall not commence until the subgrade has been approved by the Engineer.

929-4.03 Concrete Leveling Pad:

Leveling pads shall be constructed of unreinforced concrete as shown on the working drawings. Gravel leveling pads shall not be allowed. As a minimum, the concrete for leveling pads shall meet the requirements of Section 922. The elevation of the top of leveling pad shall be within 1/8 inch from the design elevation when measured by a straightedge over any 10-foot run of the leveling pad.

The minimum width of the leveling pad shall be the width of the facing unit plus eight inches. The centerline of the leveling pad shall be within 1/2 inch from design location. When the facing units are centered on the leveling pad, the leveling pad shall extend approximately four inches beyond the limits of the facing unit as measured in the direction perpendicular to the face of the wall.

Cast-in-place leveling pads shall be cured for a minimum of 24 hours before placement of wall facing units. A geotextile shall be applied over the back of the area of any openings between the facing units and leveling pad steps. The geotextile shall extend a minimum of six inches beyond the edges of the opening. The opening shall be filled with concrete, conforming to Section 1006, or shall be concurrently backfilled on both sides with soil.

929-4.04 Concrete Leveling Pad:

Prior to wall erection, the contractor shall install a subsurface drainage system as shown on the working drawings.

929-4.05 Wall Erection:

(A) General:

Walls shall be erected in accordance with the manufacturer's written instructions. The contractor shall be responsible for ensuring that a field representative from the manufacturer is available at the site during construction of the initial 10-foot height of the full length of wall, and as called upon thereafter by the Engineer, to assist the contractor and Engineer at no additional cost to the Department. All temporary construction aids (e.g., wedges, clamps, etc.) shall be in accordance with the manufacturer's recommendations.

(B) Placement Tolerances for Walls with Rigid (Precast) Facing:

For walls with rigid facing, such as precast concrete panels, the panels shall be placed such that their final position is vertical or battered as shown on the working drawings. As wall fill material is placed, the panels shall be maintained in the correct vertical alignment by means of temporary wedges, clamps, or bracing as recommended by the manufacturer. A minimum of two, but not more than three, rows of panel wedges shall remain in place at all times during wall erection. Wedges shall be removed from lower rows as panel erection progresses, so as to prevent chipping or cracking of concrete panels. The contractor shall repair any damage to erected concrete panels as directed by the Engineer and to the Engineer's satisfaction. No external wedges in front of the wall shall remain in place when the wall is complete.

Erection of walls with rigid facing shall be in accordance with the following tolerances:

(1) Vertical and horizontal alignment of the wall face shall not vary by more than 3/4 inch when measured along a 10-foot straightedge.

(2) The overall vertical tolerance (plumbness) of the finished wall shall not exceed 1/2 inch per 10 feet of wall height. Negative (outward leaning) batter is not acceptable.

(3) The maximum permissible out-of-plane offset at any panel joint shall not exceed 3/8 inch.

(4) The final horizontal and vertical joint gaps between adjacent facing panel units shall be within -1/8 inch and ±1/4 inch, respectively, of the design final joint opening per the approved calculations required in Subsection 929-3.01(H) of the specifications.

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(C) Placement Tolerances for Permanent Walls with Flexible Facing:

Erection of permanent walls with flexible facing (such as welded wire mesh) shall be in accordance with the following tolerances:

(1) Vertical and horizontal alignment of the wall face shall not vary by more than 2 inches when measured along a 10-foot straightedge, or as shown in the plans and specifications.

(2) The overall vertical tolerance (plumbness) of the wall shall not exceed one inch per 10 feet of wall height. Negative (outward leaning) batter is not acceptable.

(3) The offset limit between consecutive rows of facing shall not exceed one inch from planned offset.

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(D) Placement Tolerances for Modular Block Units:

Erection of walls with Modular Block Units shall be as per the following requirements:

(1) Vertical and horizontal alignment of the wall face shall not vary by more than 3/4 of an inch when measured along a 10-foot straightedge.

(2) Overall vertical tolerance (plumbness) of the wall shall not exceed 1-1/4 inch per 10 feet of wall height from the final wall batter. Negative (outward leaning) batter is not acceptable.

(3) The first row of units shall be level from unit-to-unit and from front-to-back. Use the tail of the units for alignment and measurement.

(4) All units shall be laid snugly together and parallel to the straight or curved line of the wall face.

(5) Unless otherwise noted, all blocks shall be dry-stacked and placed with each block evenly spanning the joint in the row below (running bond). Shimming or grinding shall control the elevations of any two adjacent blocks within 1/16 of an inch.

(6) The top of blocks shall be checked with a straight edge bubble level that is at least three feet long. Any high points identified by the straight edge shall be ground flat. Block front to back tilting shall be checked frequently; however, correction by shimming shall be done no later than three completed courses.

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(E) Placement Tolerances for Modular Block Units:

Metallic reinforcement elements shall be placed normal (perpendicular) to the face of the wall, unless otherwise shown on the approved plans. All reinforcement shall be structurally connected to the wall face.

At each level of the soil reinforcement, the reinforced wall fill material shall be roughly leveled and compacted before placing the next layer of reinforcement. The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to two inches higher than the connection elevation.

For geosynthetic reinforcement where overlapping of reinforcing may occur, such as at corners, reinforcing connections to panels shall be adjusted to maintain at least 6 inches of vertical separation between overlapping reinforcement.

(F) Placement of Geotextile Fabric:

All joints between precast concrete panels shall be covered with geotextile fabric on the back side of the wall. Adhesive shall be applied to panels only. Adhesive shall not be applied to geotextile fabric or within two inches of a joint. The contractor shall provide geotextile fabric having a minimum width of 12 inches and shall overlap the fabric a minimum of four inches. For modular block walls, the placement of the geotextile fabric shall be in accordance with the plans.

(G) Joint Pads and Fillers:

The contractor shall install joint pads and fillers as shown on the working drawings.

(H) Placement of Geosynthetic Reinforcement:

Geosynthetic reinforcement shall be installed in accordance with the manufacturer's site specific wall erection instructions.

The geosynthetic reinforcement shall be rolled out with the stronger direction perpendicular to the wall face. The reinforcement shall be continuous for their full length. Joints parallel to the wall shall not be permitted, except as shown on the working drawings.

Reinforcement coverage shall be 100 percent of embedment area unless otherwise shown in the working drawings. Adjacent sections of geosynthetic reinforcement need not be overlapped except when exposed in a wrap-around face system, at which time the reinforcement rolls shall be overlapped or mechanically connected per the manufacturer's requirements.

Geosynthetic reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geosynthetic reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geosynthetic reinforcement in position until the subsequent soil layer can be placed.

During construction, the surface of the fill shall be kept approximately horizontal. Geosynthetic reinforcement shall be placed directly on the compacted horizontal fill surface. The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to two inches higher than the connection elevation.

929-4.06 Reinforced Wall Fill Placement:

(A) General:

Reinforced wall fill placement shall closely follow erection of each course of facing panels. Backfill shall be placed in such a manner to avoid damage or disturbance of the wall materials, misalignment of facing panels, or damage to soil reinforcement or facing members. The contractor shall place backfill to the level of the connection and in such a manner as to ensure that no voids exist directly beneath reinforcing elements.

For walls with modular block facing units, the backfill shall not be advanced more than the height of a modular block unit until the drainage fill, core fill and all fill in all openings within the blocks at that level have been placed. The filled units shall be swept clean of all debris before installing the next level of units and/or placing the geogrid materials.

For walls with flexible facing with gabion style facing, the rock near the wall face shall be hand-placed in accordance with the recommendations of the wall manufacturer.

The maximum lift thickness before compaction shall not exceed 12 inches.

For geosynthetic reinforcements, the fill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the geogrid remains taut. Construction equipment shall not operate directly on the geogrid. A minimum fill thickness of six inches over the geogrid shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

For metallic reinforcements, the fill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the steel reinforcement remains normal to the face of the wall. Construction equipment shall not operate directly on the steel reinforcement. A minimum fill thickness of three inches over the steel reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

Wall materials which are damaged during backfill placement shall be removed and replaced by the contractor, at no additional cost to the Department. The contractor may submit alternative corrective procedures to the Engineer for consideration. Proposed alternative corrective procedures shall have the concurrence of the MSE wall supplier and designer, in writing, prior to submission to the Engineer for consideration. All corrective actions shall be at no additional cost to the Department.

(B) Compaction:

Reinforced wall fill compaction requires a minimum of two roller passes of a vibratory roller having a minimum dynamic force of 6,000 pounds impact per vibration, and a minimum frequency of 1,000 vibrations per minute.

The vibratory roller shall be operated at speeds less than three feet per second.

Backfill within three feet of the wall face shall be compacted utilizing a hand operated vibratory plate.

Retained backfill shall be compacted and tested per section 203-10.03 (Embankment Construction Requirements) of the specifications which require 100 percent of the maximum density for an additional 50 feet beyond the limits of approach slabs.

(C) Protection of the Work:

The contractor shall not allow surface runoff from adjacent areas to enter the wall construction site at any time during construction operations. In addition, at the end of each day's operation, the contractor shall slope the last lift of backfill away from the wall facing so that runoff is directed away from the structure. If the subgrade is damaged due to water or otherwise, such that it does not meet the requirements of Subsection 929-4.02, then as directed by the Engineer, the contractor shall rework

and repair the damaged subgrade at no additional expense to the Department. The criteria in Subsection 929-4.02 of the specifications shall be used to judge the adequacy of the repair. Rework and repair shall extend to a depth where undamaged work is encountered.

929-5 Method of Measurement:

Mechanically Stabilized Earth (MSE) retaining walls will be measured by the square foot of completed wall, based on the vertical height and length of the retaining wall shown on the plans. The vertical height will be taken as the difference in elevation measured from the top of wall to the minimum embedment reference line as indicated on the plans.

The entire surface of retaining walls shown on the plans, including all wall terminations and cast-in-place coping, will be measured as MSE retaining wall.

929-6 Basis of Payment:

The accepted quantities of Mechanically Stabilized Earth (MSE) retaining walls, measured as provided above, will be paid for at the contract unit price per square foot of wall, complete in place. Such price shall include full compensation for furnishing all designs, design revisions, associated working drawings, engineering calculations, labor, materials, tools, equipment, and incidentals. Such price shall also include provision of manufacturer's field representative, and all work involved in constructing the MSE retaining walls, including foundation preparation, proof-rolling, footings, drainage features, wall facing, slip joints, concrete or shotcrete caps and aprons, rustication, paint or stain, grout, tendons, cables, anchors, fabric, and all hardware and reinforcing steel, complete in place as shown on the plans and as specified herein.

No separate measurement or payment will be made for excavation, reinforced backfill, and retained backfill associated with MSE retaining walls, the cost of such work being considered as included in the price paid for the MSE retaining wall.

No separate measurement or payment will be made for the design, construction, or removal of temporary excavation support systems (shoring), or associated geotechnical review, the cost of such work being considered as included in the price paid for the MSE retaining wall.

SECTION 1001 MATERIAL SOURCES:

1001-1 Description:

The work under this section shall consist of the procuring of borrow, topsoil, subbase and base materials, mineral aggregates for concrete structures, surfacing, and landscape plating, from sources either designated on the project plans or in the Special Provisions or from other sources.

1001-2 General:

The contractor shall determine for itself the type of equipment and work required to produce a material meeting the requirements of the specifications.

Sites from which material has been removed shall, upon completion of the work, be left in a neat and presentable condition. Where practicable, borrow pits, gravel pits, and quarry sites shall be located so that they will not be visible from the highway.

The contractor shall provide an environmental analysis, as specified in Subsection 104.12 of the specifications, for any source proposed for use regardless of whether a previously approved environmental analysis exists for the site.

In accordance with Subsection 104.12 of the specifications, the contractor may utilize an existing environmental analysis approved after January 1, 1999, provided that the analysis is updated as necessary to be in compliance with current regulations and with the contractor's planned activities.

It shall be the responsibility of the contractor to conduct any necessary investigations, explorations, and research, on-site and otherwise, before and after submitting the bid proposal, to satisfy itself that the specified quantity and/or quality of material exists in any proposed material source.

The contractor shall not produce material for the project, mobilize crushing equipment or clear a worksite prior to approval of the environmental analysis.

The contractor shall comply with the requirements of the landowner or agency having jurisdiction over the land.

The Department makes no representation regarding quality or quantity of materials in any source.

1001-2.01 Information Available:

The Department maintains a listing of materials sources for which a completed environmental analysis is available and the landowner has allowed the source to be placed on the list. Further information on material sources is available at https://azdot.gov/business/environmental-planning/material-source-guidance.

1001-2.02 Material Sources in Floodplains:

Any development of a material source that is determined to be in a flood plain must meet the requirements of the appropriate local, state, and federal agencies, including as applicable, the U.S. Army Corps of Engineers, Section 404 of the Clean Water Act, ADEQ or Tribal 401 Water Quality Certification, and the National or Arizona Pollutant Discharge Elimination System (NPDES/AZPDES).

If the contractor wishes to procure a material source within a floodplain, the contractor or material supplier shall submit a Floodplain Use Permit application to the appropriate floodplain management agency. The contractor shall submit to the Department documentation that the Floodplain Use Permit for the material source was approved and signed by the appropriate agency's Floodplain Administrator. The contractor or material supplier shall comply with all the requirements of the Floodplain Use Permit, including renewal of the Permit as needed or required.

The Department will require an engineering report if the material source is situated in the 100 year floodplain of any stream or watercourse, and located within one mile upstream and two miles downstream of any highway structure or surfaced roadway crossing. The engineering report shall be prepared by a professional engineer with expertise in hydrology, hydraulics, river mechanics, and fluvial geomorphology. The engineering report shall address the effects of the potential for structural damages following a 100 year flood event.

All other permits required to obtain a material source shall be furnished to the Department upon request.

Surplus material from agency administered flood control management projects may be used as borrow material only if the contractor submits written evidence to the Engineer that the flood control agency project was fully designed and funded.

Material sources in floodplains located on Native American Tribal Lands will be considered for use on an individual analysis. The analysis shall include a review of applicable land use plans, floodplain management plans, environmental plans, applicable laws and regulations pertaining to Native American Tribal Lands, and an engineering analysis of the effects on any highway facility or structure. The contractor shall obtain from the Bureau of Indian Affairs (BIA) and the Native American Tribal Council all permits, licenses, and approvals for the Department to review.

1001-2.03 Protection and Restoration:

The contractor shall comply with the requirements of Subsections 107.11 and 107.12 of the specifications for protecting and restoring the material source. The contractor shall assume full responsibility to protect and rehabilitate the material source to the satisfaction of the Department and in compliance with the requirements of the Federal Land Management Agency (FLMA) having jurisdiction or by the owner of the material source.

1001-3 Proposed Source:

1001-3.01 Approval Requirements:

(A) General:

The contractor shall notify the Engineer prior to or at the preconstruction conference as to the source that it proposes to use.

The contractor acknowledges that all the conditions set forth in this subsection shall be met prior to the source being approved for use.

Other than sampling and testing, the requirements of this subsection shall be completed prior to initiation of any activities that disturb the existing conditions at the proposed source.

Regulatory changes, specification changes, or other reasons may preclude the approval of a materials source. The contractor acknowledges that the Department may refuse to approve a material source even if the Department had approved the source for other projects.

(B) Specific Conditions for Approval:

The use of a source will require written approval by the Engineer. No approval will be given until the contractor has complied with the following conditions:

(1) The contractor has submitted an environmental analysis, as specified in Subsection 104.12 of the specifications, of the source proposed for use and the Department has reviewed the analysis and satisfied itself that the use of such source will not have an adverse social, economic or environmental impact. The requirements of Subsection 1001-3.01 of the specifications shall be completed prior to initiation of any activities that disturb the existing conditions at the proposed source.

(2) The contractor has furnished the Engineer with evidence that he has secured the rights to the source, including ingress and egress.

(C) Historical and Cultural Resources:

The archaeological survey report of the proposed material source shall be prepared by the contractor's archaeological consultant and shall conform to the requirements of Subsection 104.12 of the specifications.

In the event that prehistoric or historic structures and prehistoric or historic artifacts are encountered during any activity related to the construction of the material source, the contractor shall immediately cease operations within a 50 foot radius of the discovery location and notify the Engineer. In the event that an unmarked human burial and/or funerary remains are encountered during any activity related to the construction of the material source, the contractor shall immediately cease operations within a 100 foot radius of the discovery location and notify the Engineer. The Engineer will contact the Environmental Planning – Historic Preservation Team so that appropriate notification of the discovery is made per state and federal regulations.

After notifying the Engineer, the contractor shall, within good faith, secure the area and take all reasonable measures to protect the historical and cultural resources. No activity shall resume unless authorized by the Engineer. The Engineer will not authorize resumption of any activity until receiving confirmation from the Environmental Planning – Historic Preservation Team that the contractor may commence work.

If the Department determines that the proposed use will have major adverse impact on cultural or historic resources, the Department will not allow the use of the source.

(D) Permit from Navajo Nation:

For projects located on the Navajo Reservation, the Navajo Nation has adopted a permitting system for any sources, regardless of whether on or off the Navajo reservation, which are to supply material for projects located within its boundaries. No material source will be approved until the contractor submits a copy of the permit from the Navajo Nation allowing materials from the proposed source to be used on the project. For information concerning the permit, the contractor shall contact the Navajo Nation Historic Preservation Office.

(E) Bureau of Land Management Material Sources:

If the contractor elects to pursue the use of material sources on BLM land under Title 30 Code of Federal Regulations, it is at the contractor's sole risk, and the Department bears no responsibility for any delays or costs associated with the request to use material sources on BLM Land.

The Department will not request or pursue any “free-use permit” under Title 23 Code of Federal Regulations or any other arrangement with BLM.

No extension to contract time or compensation will be granted for any attempt by the contractor to utilize BLM land.

1001-4 Special Access within Right Of Way:

The contractor may submit a request to the District Engineer to approve special access to a controlled access highway if special access is not shown on the project plans.

The request by the contractor shall be accompanied by an environmental analysis and by documents which specify the point(s) of access, the acquisition of right-of-way, the manner in which access will be attained, the traffic control plan, and crossovers, along with all other appropriate data which will allow the District Engineer to evaluate its request. If the request is approved, a supplemental agreement shall be entered into.

All costs associated with the special access requested by the contractor shall be borne by the contractor, including, but not limited to, cattle guards, fences, gates and restoration work.

When access is not being utilized, gates shall be closed and locked. Upon completion of all operations, the area within the right-of-way that has been disturbed shall be restored to the condition existing prior to the contractor's operations.

The decision by the District Engineer to deny a request by the contractor will be considered to be final.

1001-5 Fences and Cattle Guards:

Where the haul roads to material sources cross existing fence lines in areas where there is livestock of any kind, temporary cattle guards shall be installed by the contractor at each crossing.

The livestock operator or owner shall be contacted prior to the beginning of any operations and effective measures shall be taken and means provided by the contractor to prevent livestock from straying.

In operations where conditions will exist that are dangerous to livestock of any kind, temporary cattle guards and fence shall be installed around the pit area by the contractor to protect livestock.

Temporary cattle guards and fence installed by the contractor shall be removed and existing fence disturbed shall be replaced or reconstructed and all fence shall be left in as good condition as it was prior to the beginning of work.

SECTION 1002 PAINT:

1002-1 General Requirements:

All paints specified herein shall be ready-mixed at the manufacturer's plant, except for inorganic zinc rich primer, which shall be mixed by the fabricator or at the project site just prior to application. All paints shall be standard paint products of the manufacturer with published product data sheets and shall comply in all details with the specifications.

Ready-mixed paint shall be homogeneous, free of contaminants, and shall be of a consistency suitable for the use for which it is specified. The pigment shall be finely ground and properly dispersed in the vehicle, according to the requirements for the type of paint, and this dispersion shall be such that the pigment does not settle appreciably, does not cake or thicken in the paint container, and does not exhibit signs of phase separation or become granular, jelled, or curdled. Any settlement of pigment in the paint shall be easily dispersed with a paddle so as to produce a smooth uniform paint of the proper consistency. The manufacturer shall include in the paint the necessary additives for control of sagging, leveling, drying, drier absorption, and skinning.

Lead, lead compounds, soluble barium compounds, or hexavalent chromium compounds shall not be used as raw materials in the paint formulas specified under this section, and shall not be added to any paint formulas specified under this section.

The use of halogenated solvents is not permitted.

All paints shall comply with applicable volatile organic compound (VOC) limits as established by federal, state, and local environmental regulations, including those set by the U.S. Environmental Protection Agency (EPA). VOC content shall be determined in accordance with ASTM D3960.

Paint shall be furnished in new, unopened air-tight containers, which are clearly labeled with the exact title of the paint, Federal Specification number when applicable, name and address of the manufacturer, product code, date of paint manufacture, and the lot or batch number. The containers shall meet U.S. Department of Transportation Hazardous Materials Shipping Regulations. Precautions concerning the handling and the application of the paint shall be shown on the label of the paint containers.

All of the paints of any coating system consisting of individual paints (such as a primer, intermediate coat, and topcoat), shall be made by the same manufacturer, and shall be designed and sold to be used together as a system.

The contractor shall submit to the Engineer a Certificate of Compliance for each lot or batch of paint supplied, in accordance with

Subsection 106.05 of the specifications, prior to its use. Product data sheets listing the paint constituents and their proportions as well as Materials Safety Data Sheets (MSDS) are required for each paint material supplied prior to its use.

All applicable governmental environmental regulations shall be adhered to during cleanup and for the disposal of unused paint.

1002-2 Paint Types:

1002-2.01 Water-Based Paint for Structural Steel and Other Metallic Metals:

(A) Three-Paint Coating System:

(1) General:

A three-paint coating system shall be for use on metallic surfaces, and shall include a primer (Paint Number 1), intermediate coat (Paint Number 2), and topcoat (Paint Number 3) from the same system. All three paints shall be water-based, 100 percent acrylic (acrylic latex) paints, unless a non water-based primer is specified, in which case, the topcoat and intermediate coat must be a water-based acrylic paint.

Each individual paint shall conform to all of the chemical and physical characteristics and properties as declared on the manufacturer's product data sheet. In addition, the paint color shall be as specified in the project plans, and the consistency shall be in accordance with the manufacturer's recommendations. The contractor shall use the checking and calibration procedures found in ASTM D4212 and verify the paint consistency with the Engineer prior to each application.

Each coating is intended for spray application. Limited application can be made by brushing or rolling if approved by the Engineer.

(2) Paint Number 1 - Primer:

This paint shall be used on blast cleaned steel surfaces for the first coat of a three-paint coating which must include Paint Number 2 and Paint Number 3 from the same system. The blast cleaned steel surface shall be in accordance with ASTM D4417, Method C.

(3) Paint Number 2 - Intermediate Coat:

This paint for intermediate coats shall be used on primed steel surfaces as the second coat of a three-paint coating system which must include Paint Number 1 and Paint Number 3 from the same system. The paint shall be appropriately tinted to contrast with the prime coat.

(4) Paint Number 3 - Topcoat:

Paint for topcoats shall be used as the third coat of a three-paint coating system which must include Paint Number 1 and Paint Number 2 from the same system.

For topcoats, the gloss shall be as specified on the project plans. The available colors for topcoats shall provide visual matches to the colors given in the Federal Standard No. 595. The colors shall be available in high-gloss enamels, if required.

(B) Direct-to-Metal (DTM) Combination Primer and Finish Paint:

This paint shall be a water-based acrylic paint specially designed for use as a direct-to-metal (DTM) primer or combination primer and finish. The product shall be certified by the manufacturer to form a strong bond to properly cleaned and prepared surfaces of structural steel and other metallic products such as metal buildings, tanks, and pipes. It shall also be certified to bond with other properly cleaned and prepared surfaces such as galvanized steel, oil-based paints, and alkyd enamels. When used on ferrous metal surfaces where there are rusting issues, the paint shall be rust-inhibitive. Direct-to-metal combination primer and finish paints shall be designed to be usable as a complete two or three coat system. When used as a primer only, the paint shall be certified by the manufacturer to be compatible with any suitable water-based acrylic finish paint.

1002-2.02 Solvent-Based Paint for Structural Steel and Other Metallic Metals:

These paints shall be used on blast cleaned steel surfaces. The blast cleaned steel surface shall be in accordance with ASTM D4417, Method C.

(A) Zinc Rich Primer:

Zinc-rich primer shall be a solvent based, one-part, epoxy ester, zinc-rich coating made to contain no less than 89 percent by weight of zinc dust in the dried film. Zinc-rich primer is suitable for limited use on cuts, welds, or damaged galvanized surfaces, as needed to restore the continuity of cathodic protection. Zinc-rich primer shall be certified by the manufacturer to be compatible with any suitable water-based acrylic finish paint.

Zinc-rich primer shall be used where zinc paint is called for elsewhere in the specifications.

(B) Inorganic Zinc-Rich Primer:

Inorganic zinc-rich primer shall be a solvent-based three-component, inorganic, ethyl silicate, zinc-rich coating for use on steel surfaces which will be exposed to severely corrosive environments. The primer shall be

mixed in accordance with the manufacturer's directions by the fabricator or at the project site just prior to application. Inorganic zinc-rich primer shall be made to contain no less than 80 percent by weight of zinc dust in the dried film, and shall be certified by the manufacturer to form a strong bond to properly cleaned and prepared steel surfaces, either sandblasted or galvanized. This primer shall also be certified by the manufacturer to be compatible with any suitable water-based acrylic finish paint.

(C) Alkyd Primer:

Alkyd primer shall be solvent-based, and shall be designed for ferrous metal surfaces where there are rusting issues which rule out the use of a water-based primer. Such surfaces may include ornamental iron, tanks, fabricated parts, handrails, and objects referred to as "black steel." Alkyd primer shall be certified by the manufacturer to be compatible with any suitable water-based acrylic finish paint.

1002-2.03 Water-Based Acrylic Paint for Concrete and Masonry Surfaces:

(A) Acrylic Emulsion Paint:

Acrylic emulsion paint shall be used on concrete and masonry surfaces, and shall be a waterbased, 100 percent acrylic (acrylic latex) paint.

This paint may be tinted by using "Universal" or "all purpose" concentrates.

The color of the final coat of paint shall be as indicated on the project plans. If no color is specified on the plans, the paint color shall approximate that of paint color chip No. 30318, as specified by Federal Test Standard Number 595, when applied to either a concrete test specimen measuring 2 feet by 2 feet, or to the surface of the concrete structure to be painted.

The Engineer will determine color acceptance by visual inspection.

1002-3 Sampling and Testing:

(A) General:

Any lot or batch of paint may, at any time, be sampled and tested for conformance to the specifications and the chemical and physical characteristics and properties as declared by the manufacturer on the product data sheets submitted with the original samples used in the evaluation and approval of the product. Also, complete coating system samples may be required at any time for follow-up evaluation using the performance test method employed in the original evaluation for approval of the system.

(B) Coating Systems for Structural Steel and Other Metallic Surfaces:

Coating systems composed of the paints specified in Subsections 1002-2.01 through 1002-2.05 of the specifications will be tested as complete systems applied to steel panels and weathered in accordance with ASTM G154, and exposure cycle number 4 of ASTM D4587, in the Q-U-V Accelerated Weathering Tester, utilizing UVA 340 lamps. The procedure is as follows:

(1) Paint coatings will be applied to cold rolled steel panels (ASTM D609, Type 3, ASTM A366). The paint will be thinned to 75 ± 2 Ku consistency using demineralized water. Three coats, each approximately 2 mils thickness are applied to each of four panels according to ASTM D823. The fourth coated panel from each set will be inscribed with an "X" cut to the steel substrate and extending across the entire coated area;

(2) The exposure cycle used with the weathering tester shall be D = 8 h UV/60 degree C followed by 4 h CON/45 degree C. One panel from each set of four shall be removed at 1000 hours and another at 1500 hours. The last two panels shall be removed at 2000 hours;

(3) Paint systems will be evaluated after 2000 hours of weathering and must meet the minimum performance criteria below:

(a) Adhesion: Testing will be performed in accordance with the requirements of ASTM D4541, Method E, with a minimum average adhesion strength of 300 pounds per square inch being required. No single test shall have a strength below 200 pounds per square inch;

(b) Blistering: Testing will be performed in accordance with ASTM D714. No blistering shall be observed after testing;

(c) Flexibility: Testing will be performed in accordance with ASTM D522, Method B, using a 1-1/4 inch mandrel. No cracking shall be observed after bending;

(d) Corrosion Resistance: Testing will be performed in accordance with ASTM D610 with an average rating no less than 9 required.

(C) Paint for Concrete and Masonry Surfaces:

Paint for concrete and masonry surfaces will be tested in accordance with the following procedures:

(1) Resistance to Accelerated Weathering:

The paint will be applied to concrete mortar panels and weathered in a Q-U-V accelerated weathering tester, according to ASTM G154, for 2000 hours utilizing UVA-340 lamps, and exposure cycle number 42 of ASTM D4587. The paint weathered in this manner shall show no appreciable change in color or appearance due to fading, chalking, or material reaction.

(2) Adhesion:

The paint shall be tested for adhesion in accordance with the requirements of ASTM D7234, with a strength of at least 300 pounds per square inch being required. Adhesion testing shall be performed on a concrete or masonry test surface prepared by the manufacturer, and the substrate shall have a minimum tensile strength of 400 pounds per square inch to ensure consistent results and minimize substrate failure. In addition, adhesion testing may be performed in the field in accordance with the requirements of ASTM D3359, Method A, with a rating of 3A or higher being acceptable for visual confirmation only, when applied to a surface approved by the Engineer.

SECTION 1003 REINFORCING STEEL:

1003-1 General Requirements:

Reinforcing steel shall be furnished in the sizes, shapes, and lengths shown on the plans and in conformance with the requirements of the specifications.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted for epoxy coated reinforcing bars, as well as uncoated reinforcing bars, wire, and welded wire fabric. In addition, for epoxy coated reinforcing bars, Certificates of Compliance shall be submitted from the coating manufacturer and Certificates of Analysis shall be submitted from the coating applicator.

When reinforcing steel is delivered to the project site of the work, the contractor shall furnish the Engineer with a copy of all shipping documents. Each shipping document shall show the sizes, lengths, and weights of the reinforcing steel separately for each structure.

Reinforcing steel shall be free of dirt, oil, paint and grease and shall conform to the requirements of Section 605 of the specifications. Reinforcing steel shall be protected at all times from damage. All reinforcing steel shall be free of dirt, oil, paint and grease. Rust, surface irregularities, or mill scale will not be the cause for rejection, provided

the weight, dimensions, cross-sectional area, and tensile properties of a manually wire brushed test specimen are not less than the requirements of the specifications.

1003-2 Reinforcing Bars:

Except when used for wire ties or spirals, steel bars used as reinforcement in concrete shall be deformed and shall conform to the requirements of ASTM A615 for Grade 60 steel. Unless otherwise specified, steel bars meeting the requirements of ASTM A706 may be substituted for ASTM A615 steel bars. When ASTM A706 bars are used, tack welding of the reinforcement will not be permitted unless approved in writing by the Engineer.

Samples of reinforcing bars taken at the supplier's or fabricator's place of business shall be defined as pre-shipment samples, while those samples obtained from stockpile or shipment at the project shall be defined as project samples. A shipment shall be considered any amount of reinforcing bars delivered to a project on any given day, of one transported load.

Reinforcing bars sizes No. 4, No. 5, and No. 6 will be accepted with the submission of a Certificate of Compliance. All other reinforcing bar sizes shall be subject to pre-shipment and project sampling as outlined below.

1003-2.01 Pre-Shipment Sampling:

Prior to shipment of reinforcing bars to the project, the supplier or contractor shall contact Materials Group, Structural Materials Testing Section to obtain a laboratory number referenced to the project number. A random sample shall be taken at the supplier’s place of business and delivered to the Structural Materials Testing Section. For bar size No. 14, the sample shall be one piece not less than 42 inches in length, selected at random for each shipment up to 30 tons. For bar size No. 18, the sample shall be one piece not be less than 42 inches in length, selected at random for each shipment up to 50 tons. For all other bar sizes, the sample shall be one piece not less than seven feet in length, selected at random for each shipment up to 20 tons. Samples shall be submitted for each bar size, grade, heat number, and manufacturer in the shipment. The pre-shipment bars that are obtained from the supplier or fabricator must be accompanied by a Certificate of Compliance. The information shown on the certificate must match the bar identification marks. If no Certificate of Compliance is available or the information shown on the certificate is incomplete or inaccurate, the bars will not be accepted for testing.

When the supplier or fabricator makes a shipment to a project, a Certificate of Compliance shall be furnished stating that the material in the shipment is from the same stock as the pre-shipment sample covered by the laboratory number assigned by the Structural Materials Testing Section. Reinforcing bars represented by the pre-shipment sample

failing to comply with the specification requirements shall not be used on any project.

1003-2.02 Project Sampling:

The Engineer reserves the right to sample reinforcing bars at any time. Project samples shall consist of one sample bar not less than seven feet in length for all bar sizes. Placement of the reinforcing bars shall not be delayed while the contractor is awaiting test results.

Concrete placement operations shall not begin until satisfactory test results of the project sample bars are obtained.

When the supplier or fabricator makes a shipment to a project from outside the Phoenix or Tucson areas, or not otherwise subjected to pre-shipment sampling, the shipment shall be accompanied by a Certification of Compliance. Before any reinforcing bars from a shipment is to be incorporated into the project work, a project sample shall be taken, tested, and approved by the Structural Materials Testing Section. A project sample shall be taken as soon as practical upon arrival at the job site. A different project sample that is representative of each bar size, grade, heat number, and manufacturer from that shipment will be required. The sampling requirements described for pre-shipment sampling for the Phoenix or Tucson areas shall be used.

1003-3 Wire:

Steel wire used as spirals or ties for reinforcement in concrete shall conform to the requirements of AASHTO M 336. Wire shall be deformed or cold drawn (smooth).

1003-4 Welded Wire Fabric:

Welded wire fabric for concrete reinforcement shall conform to the requirements of AASHTO M 336.

1003-5 Epoxy Coated Reinforcing Bars:

1003-5.01 Steel:

Reinforcing bars shall conform to the requirements of Subsection 1003-2 of the specifications.

Epoxy coated reinforcing bars will be sampled and tested in the same manner as uncoated reinforcing bars. The coating and flexibility of the epoxy coated reinforcing bars will also be tested by the Department for acceptance.

1003-5.02 Epoxy for Coating:

A list of powdered epoxy resins which have passed prequalification tests, as described in ASTM A775, "Epoxy Coated Steel Reinforcing Bars", is maintained on the Department's Approved Products List (APL). The powdered epoxy resins selected by the contractor and furnished by the manufacturer shall be of the same material and quality as the resins listed on the APL, and shall be applied and cured in the same manner used to coat the test bars in the original powder prequalification test. Copies of the most current version of the APL are available on the internet from the ADOT Research Center through its Product Evaluation Program.

Prequalification testing may be performed by the National Bureau of Standards, State laboratories, or qualified private independent laboratories.

The Certificate of Compliance from the coating manufacturer shall properly identify the batch and/or lot number, material, quantity of batch, date of manufacture, name and address of manufacturer, and a statement that the material is the same composition as the initial sample prequalified for use. The certificate shall also state that production bars and prequalification bars have been identically prepared and applied with epoxy powders.

Patching or repair material, compatible with the coating and inert in concrete, shall be made available by the epoxy coating manufacturer. This material shall be suitable to repair areas of the coating damaged during fabrication or handling in the field.

1003-5.03 Application of Coating:

The coating applicator's facilities shall be subject to approval by the Department. Applications for approval of facilities shall be made to the Department by the coating applicator.

The surface to be coated shall be blast cleaned in accordance with the requirements of the Society for Protective Coatings, Surface Preparation Standard SSPC-SP10, Near White Blast Cleaning.

The powdered epoxy resin coating shall be applied to the cleaned surface as soon as possible after cleaning and before visible oxidation occurs. In no case shall more than eight hours elapse between cleaning and coating.

The protective epoxy coatings shall be applied by the electrostatic spray method or the electrostatic fluidized bed method in accordance with the recommendations of the coating manufacturer. The epoxy coating may be applied before or after fabrication of the reinforcing bars.

The epoxy coating shall be applied as a smooth uniform coat. After curing, the coating thickness shall be in accordance with the requirements of ASTM A775. Coating thickness shall be controlled by

taking measurements on a representative number of bars from each production lot. Coating thickness measurements shall be conducted by the method outlined in the Society for Protective Coatings Paint Application Standard SSPC-PA2.

The coating shall be checked visually after cure for continuity. It shall be free from holes, voids, contamination, cracks, and damaged areas.

The coating shall not have more than two holidays (pinholes not visible to the naked eye) in any linear foot of the coated item. A holiday detector shall be used, in accordance with the manufacturer's instructions, to check the coating for holidays.

The flexibility of the coating shall be evaluated on a representative number of bars selected from each production lot. The coated bar shall be bent 120 degrees (after rebound) around a six-inch diameter mandrel. The bend shall be done at a uniform rate and may take up to one minute to complete. The test specimens shall be at thermal equilibrium between 68 and 85 degrees F at the time of testing. No cracking of the coating shall be visible to the naked eye on the outside radius of the bent bar.

The contractor shall furnish a Certificate of Analysis from the coating applicator with each shipment of coated steel. In addition to the requirements of Subsection 106.05 of the specifications, the Certificate of Analysis shall state that the coated items and coating material have been tested in accordance with the requirements of this subsection and that the entire lot is in a fully cured condition.

The coating applicator shall be responsible for performing quality control and tests. This will include inspection and testing to determine compliance with the requirements of this subsection for the coating thickness, continuity of coating, coating cure, and flexibility of coating.

The Department reserves the right to have its authorized representative observe the preparation, coating, and testing of the reinforcement bars. The representative shall have free access to the plant, and any work done when access has been denied will be automatically rejected.

If the representative elects, lengths of coated bars may be taken from the production run on a random basis for test, evaluation, and check purposes by the Department.

1003-5.04 Shop Repair:

Epoxy coated reinforcing bars which do not meet the requirements for coating thickness, continuity of coating, coating cure, or flexibility of coating shall not be repaired.

Reinforcing bars with these defects shall be replaced, or alternately stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

Coating breaks due to fabrication and handling shall be repaired with patching material if the defective area exceeds 2 percent of the surface area of the bar in a one-foot length and the damaged spot is larger than 1/4 inch by 1/4 inch.

The repair of coating breaks shall be limited to bars on which the total of the defective coating areas does not exceed 5 percent of the surface area of the reinforcing bar. Bars with greater than 5 percent damage shall be replaced, or alternately stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

1003-6 Prestressing Reinforcing Steel:

Prestressing reinforcing steel shall conform to the requirements of Section 602-2.01 of the specifications.

Prestressing steel shall be high-tensile steel wire, high-tensile seven-wire strand or high-tensile alloy bars, as shown in the plans.

High-tensile steel wire shall conform to the requirements of AASHTO M 204.

High-tensile seven-wire strand shall conform to the requirements of AASHTO M 203 for Grade 270. In addition to the 0.5-inch diameter prestressing steel typically shown on the plans, 0.6-inch diameter seven-wire strand may be used for cast-in-place prestressed structures.

High-tensile alloy bars shall conform to the requirements of AASHTO M 275.

All prestressing steel shall be satisfactorily protected from damage by abrasion, moisture, rust, or corrosion and shall be free of dirt, rust, oil, grease, or other deleterious substances.

For every five reels of prestressing steel furnished, one sample not less than six feet long, will be tested by the Engineer. Samples of the furnished reels with the manufacturer's Certificate of Compliance, a mill certificate, and a test report may be shipped directly by the manufacturer to the Engineer.

1003-7 Dowel Bars for Portland Cement Concrete Pavement:

Dowel bars shall be round, plain steel bars of the dimensions shown on the plans conforming to the requirements of AASHTO M 254 with Type B coating. The core material shall conform to the requirements of ASTM A615, Grade 60.

Epoxy coated dowel bars shall also conform to the requirements of Subsection 1003-5 of the specifications.

The contractor shall furnish a Certificate of Compliance that properly identifies the coating material, the number of each batch of coating material used, quantity represented, date of manufacture, name and address of manufacturer, and a statement that the supplied coating material meets the requirements of AASHTO M 254 with Type B coating.

SECTION 1004 STRUCTURAL METALS:

1004-1 General Requirements:

Certificates of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1004-2 Structural Steel:

Structural carbon steel shall conform to the requirements of AASHTO M 183 (ASTM A36).

High strength low-alloy structural columbium vanadium steel shall conform to the requirements of AASHTO M 223.

High strength low-alloy structural steel up to 4 inches thick with 50,000 pounds per square inch minimum-yield point shall conform to the requirements of AASHTO M 222 (ASTM A588).

1004-3 Steel Structural Rivets:

Steel structural rivets shall conform to the requirements of AASHTO M 228 (ASTM A502).

1004-4 Bolts, Nuts, and Washers:

High strength structural steel, bolts and washers shall conform to the requirements of Section 604-2.03 of the specifications.

Bolts and nuts other than high strength steel bolts shall conform to the requirements of ASTM A307, Grade A.

Nonheaded anchor bolts, either straight or swaged, to be used for structural anchorage, shall conform to the requirements of AASHTO M 183 (ASTM A36).

1004-5 Steel Forgings:

Carbon steel forgings shall conform to the requirements of AASHTO M 102 (ASTM A668, Class C).

1004-6 Castings:

Carbon steel castings shall conform to the requirements of AASHTO M 103 (ASTM A27, Grade 65-35). Gray iron castings shall conform to the requirements of AASHTO M 105 (ASTM A48, Class 30B). Malleable iron castings shall conform to the requirements of ASTM A47, Grade 35018.

Drainage structure castings shall conform to the requirements of AASHTO M 306. The weight of aluminum covers shall not be less than 150 pounds.

1004-7 Cast Bronze and Copper-Alloy Plates:

Cast bronze bearing and expansion plates shall conform to the requirements of AASHTO M 107 (ASTM B22, Copper Alloy UNS No. C 91100). Rolled copper-alloy bearing and expansion plates shall conform to the requirements of AASHTO M 108 (ASTM B100, Copper Alloy UNS No. C 51000 and No. C 51100).

1004-8 Steel Tubes:

Steel tubes, low-carbon, tapered for structural use shall conform to the requirements of ASTM A595, Grade A.

1004-9 Steel Pipe:

Steel pipe shall conform to the requirements of ASTM A53, Grade B, Type E or S, except hydrostatic testing will not be required.

SECTION 1005 BITUMINOUS MATERIALS:

1005-1 General Requirements:

Bituminous materials shall conform, when tested in accordance with the tests hereinafter enumerated, to the following requirements, as applicable, for the types and grades designated and used.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1005-2 Sampling of Bituminous Material:

Sampling of bituminous material shall conform to the requirements of AASHTO R 66. Samples shall be taken by the contractor and witnessed by the Engineer. The point of sampling and the number of samples will be specified by the Engineer.

The contractor shall provide convenient facilities for obtaining accurate samples of bituminous material.

1005-3 Bituminous Material Requirements:

1005-3.01 Asphalt Cement:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of AASHTO M 320. Air blown/oxidized asphalt, Polyphosphoric acid (PPA) modification and re-refined/recycled engine oil bottom (REOB) will not be accepted. The pressure aging temperature for all binders, including Terminal Blend rubberized binder and Polymer modified asphalt binder, shall be as specified below:

PG Asphalt Binder	Pressure Aging Temperature
PG 70-XX and above	110 ºC
PG 64-XX and below	100 ºC

If Terminal Blend rubberized binder (XX-XXTR+) is used, it shall conform to the requirements of Table 1005-1 and 1005-1a.

If Polymer modified asphalt binder (XX-XXPM) is used, it shall conform to the requirements of Table 1005-1 and 1005-1b.

If, during asphaltic concrete production, it is determined by testing that asphalt cement fails to meet the requirements for the specified grade, the asphaltic concrete represented by the corresponding test results shall be evaluated for acceptance. Should the asphaltic concrete be allowed to remain in place, the contract unit price for asphaltic concrete will be adjusted by the percentage shown in Table 1005-1. Should the asphalt cement be in reject status, the contractor may, within 25 days of receiving notice of the reject status, supply an engineering analysis of the expected performance of the asphaltic concrete in which the asphalt cement is incorporated. The engineering analysis shall detail any proposed corrective action and the anticipated effect of such corrective action on the performance. Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is rejected, the asphaltic concrete shall be removed and replaced with asphaltic concrete meeting the requirements of the specifications at no additional expense to the Department. If the contractor's proposal is accepted, the asphaltic concrete shall remain in place at the applicable percent of contract unit price allowed, and any necessary corrective action shall be performed at no additional cost to the Department.

1005-3.02 Liquid Asphalt:

Liquid asphalt shall conform to the requirements of AASHTO M 82, Cut-back Asphalt (Medium Curing Type).

Adjustments in the contract unit price, in accordance with the requirements of Table 1005-2, will be made for quantities of material represented by the corresponding test results.

1005-3.03 Emulsified Asphalt:

Emulsified asphalt shall conform to the requirements of Table 1005-3 for Anionic Rapid Set (RS-1, RS-2), Anionic Slow Set (SS-1), Cationic Rapid Set (CRS-1, CRS-2) and Cationic Slow Set (CSS-1).

Polymerized Cationic Rapid Set (CRS-2P) emulsified asphalt shall conform to the requirements of Table 1005-3a.

Polymerized High Float (HFE-150P) and (HFE-300P) emulsified asphalt shall conform to the requirements of Table 1005-3b.

Emulsified asphalts shall be homogeneous. If emulsified asphalt has separated, it shall be thoroughly mixed to ensure homogeneity. If emulsified asphalt has separated due to freezing, it shall not be used. Emulsified asphalt shall not be used after 30 days from production.

The contract unit price will be adjusted, to the nearest cent, for quantities of emulsified asphalt which do not meet the specified minimum percent residue. The adjusted contract unit price will be determined by the following:

$$\left[\begin{array}{c}\text{Adjusted Contract}\\ \text{Unit Price}\end{array}\right] = \frac{\left[\begin{array}{c}\text{Percent Residue}\\ \text{From Testing}\end{array}\right]}{\left[\begin{array}{c}\text{Specified Minimum}\\ \text{Percent Residue}\end{array}\right]} \times \left[\text{Contract Unit Price}\right]$$

1005-3.04 Emulsified Asphalt (Special Type):

Emulsified asphalt (special type) shall consist of Type SS-1 or CSS-1 diluted with water to provide an asphalt content not less than 26 percent. The water used shall be potable. Potable water obtained from public utility distribution lines will be acceptable. The water used shall be free of injurious amounts of oil, acid, alkali, clay, vegetable matter, silt, or other harmful matter. The material shall not be diluted in the field.

1005-3.05 Recycling Agents:

Recycling agents shall conform to the requirements of Table 1005-4.

1005-3.06 Emulsified Recycling Agents:

Emulsified recycling agents shall conform to the requirements of Table 1005-5.

The contract unit price will be adjusted, to the nearest cent, for quantities of emulsified recycling agent which do not meet the specified minimum percent residue. The adjusted contract unit price will be determined by the following:

$$\left[\begin{array}{c}\text{Adjusted Contract}\\ \text{Unit Price}\end{array}\right] = \frac{\left[\begin{array}{c}\text{Percent Residue}\\ \text{From Testing}\end{array}\right]}{\left[\begin{array}{c}\text{Specified Minimum}\\ \text{Percent Residue}\end{array}\right]} \times \left[\text{Contract Unit Price}\right]$$

1005-3.07 Other Requirements:

Other requirements for bituminous materials shall conform to the requirements of Table 1005-6.

TABLE 1005-1
ASPHALT BINDER ADJUSTMENT TABLE

Test Property	AASHTO Test Method	Test Result	Percent of Contract Unit Price Allowed
Dynamic Shear of Original Binder: G*/Sin δ, kPa	T 315	≥ 1.00 0.90-0.99 0.70-0.89 < 0.70	100 98 95 88 (1)
Dynamic Shear of RTFO Binder: G*/Sin δ, kPa	T 315	≥ 2.20 2.00-2.19 1.60-1.99 < 1.60	100 98 95 88 (1)
Dynamic Shear of PAV Binder: G*Sin δ, kPa	T 315	≤ 5000 5001-5500 5501-7000 7001-8000 > 8000	100 98 95 89 87 (1)
Creep Stiffness of PAV Binder: S, Mpa	T 313	≤ 300 301-330 331-450 451-600 > 600	100 98 95 89 87 (1)
m-value at 60 sec.	T 313	≥ 0.300 0.270-0.299 0.230-0.269 < 0.230	100 98 90 87 (1)

Notes:

(1) Reject Status: The pay adjustment applies if allowed to remain in place.

(2) Specified properties in AASHTO M 320 for flash point, viscosity at 135 °C, and mass loss are not considered performance related. Specification deficiencies for these properties shall be cause for a work stoppage until specification properties are met, but will not be cause for a pay adjustment.

(3) Should the bituminous material be deficient on more than one property, the pay adjustment will be the greatest reduction to the contract unit price specified considering individual test results.

(4) The information presented in this table does not apply to asphalt cement used for tack coats.

TABLE 1005-1a
TERMINAL BLEND RUBBERIZED BINDER (XX-XXTR+)

Test Property	Test Method	Requirement	Test Result	Percent of Contract Unit Price Allowed
Solubility, %, minimum	ASTM D7553 or ASTM D2042	98	-----	-----
Elastic Recovery, @ 10 ºC, %, minimum	AASHTO T 301	75	75 70 - 74 < 70	100 89 87 (1)

(1) Reject Status: The pay adjustment applies if allowed to remain in place.

Notes:

In case of dispute, ASTM D2042 shall be used to determine the Solubility.

The asphalt binder shall contain a minimum of 8 percent crumb rubber and a minimum of 3 percent SBS (styrene-butadiene-styrene) polymer.

The crumb rubber shall be derived from processing whole scrap tires or shredded tire materials. The tires from which the crumb rubber is produced shall be taken from automobiles, trucks, or other equipment owned and operated in the United States. The processing shall not produce, as a waste product, casings or other round tire material that can retain moisture when stored or disposed of above ground.

Modified binders shall be blended at the source of supply and delivered as a homogenous mixture to the job site.

Modified Binders stored at the asphalt concrete mixing plant for more than two weeks or beyond the supplier recommended shelf life, whichever is less, shall be sampled and tested.

TABLE 1005-1b
POLYMER MODIFIED ASPHALT BINDER (XX-XXPM)

Test Property	Test Method	Requirement	Test Result	Percent of Contract Unit Price Allowed
Solubility, %, minimum	ASTM D7553 or ASTM D2042	98	-----	-----
Elastic Recovery, @ 10 ºC, %, minimum	AASHTO T 301	75	≥ 75 70 - 74 < 70	100 89 87 (1)

(1) Reject Status: The pay adjustment applies if allowed to remain in place.

Notes:

In case of dispute, ASTM D2042 shall be used to determine the Solubility.

Asphalt binder shall contain a minimum of 3 percent SBS (styrene-butadiene-styrene) polymer.

Modified binders shall be blended at the source of supply and delivered as a homogenous mixture to the job site.

Modified Binders stored at the asphalt concrete mixing plant for more than two weeks or beyond the supplier recommended shelf life, whichever is less, shall be sampled and tested.

TABLE 1005-2

MC LIQUID ASPHALT PAY ADJUSTMENT TABLE

Grade	Kinematic Viscosity (AASHTO T 201): Centistokes, Deviations	Percent of Contract Unit Price Allowed
70	70 - 140 63 - 69 or 141 - 154 52 - 62 or 155 - 175 Less than 52 or greater than 175	100 90 75 60 (1)
250	250 - 500 225 - 249 or 501 - 550 187 - 224 or 551 - 625 Less than 187 or greater than 625	100 90 75 60 (1)
800	800 - 1600 720 - 799 or 1601 - 1760 600 - 719 or 1761 - 2000 Less than 600 or greater than 2000	100 90 75 60 (1)
3000	3000 - 6000 2700 - 2999 or 6001 - 6600 2250 - 2699 or 6601 - 7500 Less than 2250 or greater than 7500	100 90 75 60 (1)

Note:

(1) Reject Status: The pay adjustment applies if allowed to remain in place.

(2) Since volatile solvents utilized in the manufacture of MC Liquid Asphalt may volatilize in varying amounts during transporting, handling, and storage operations, whenever such Liquid Asphalts are used for prime coats or curing seals, deviations from the maximum specification limits greater than those listed may be permitted when justified. In such cases, when material is allowed to remain in place, 60 percent of the contract unit price is allowed.

TABLE 1005-3
EMULSIFIED ASPHALTS

Tests on Emulsion	Test Method (1)	Requirement					
		RS-1	CRS-1	RS-2	CRS-2	SS-1	CSS-1
Viscosity: Saybolt Furol, seconds, range 77 °F 122 °F	T 59	20-100	20-100	50-400	50-400	20-100	20-100
Settlement: 5 days, %, maximum	T 59	5	5	5	5	5	5
Sieve: Retained on No. 20, %, maximum	T 59(2)	0.10	0.10	0.10		0.10	0.10
Particle Charge	T 59		Pos.		Pos.		Pos. (3)
Demulsibility: 35 mL, 0.02 N calcium chloride %, minimum	T 59	60		60			
Classification: Uncoated particles, %, minimum	Arizona Test Method 502				55		
Residue: (4) Residue, %, minimum (5)		55	60	63	65	57	57

Notes:

(1) “T 59” is AASHTO T 59.

(2) Distilled water shall be used. Two percent sodium oleate solution will not be accepted.

(3) If the Particle Charge Test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

(4) Residue will be obtained in accordance with the requirements of Arizona Test Method 504 and shall conform to all the requirements of AASHTO M 320 for PG 64-16, except that for CRS-2 the dynamic shear (G*/Sin δ) on the original residue shall be a minimum of 1.00 kPa and a maximum of 1.50 kPa.

(5) Residue by evaporation may be determined in accordance with the requirements of Arizona Test Method 512; however, in case of dispute, AASHTO T 59 will be used.

TABLE 1005-3a
POLYMERIZED CATIONIC RAPID SET (CRS-2P) EMULSIFIED ASPHALT (1)

Tests on Emulsion:	Test Method	Requirement
Viscosity, Saybolt Furol seconds @ 50 ºC (122 ºF), range	AASHTO T 59	100-400
Storage Stability, 24 hours, % maximum	AASHTO T 59	1
Demulsibilty, 35 mL of 0.8% DSS, % minimum	AASHTO T 59	40
Particle Charge Test	AASHTO T 59	Positive
Sieve Test, retained on 850 µm (No. 20), % maximum	AASHTO T 59	0.10
Residue from Distillation to 176.7 ºC (350 ºF), % minimum	AASHTO T 59	66
Oil Distillate to 176.7 ºC (350 ºF), Volume of Emulsion, % maximum	AASHTO T 59	0.5
Tests on Residue from Distillation:		
Penetration, 25 ºC (77 ºF), 100 grams, 5 seconds, range in 0.1 mm	AASHTO T 49	40-100
Ductility, 4 ºC (39.2 ºF), 10 mm/minute, cm, minimum	AASHTO T 51	35
Elastic Recovery by means of Ductilometer, 25 ºC (77 ºF), % minimum	AASHTO T 301 (2)	55

Notes:

(1) The introduction of polymer shall occur before emulsification.

(2) Testing shall be performed on residue by distillation. Testing on residue by oven evaporation will not be accepted.

TABLE 1005-3b
POLYMERIZED HIGH FLOAT EMULSIFIED ASPHALT (1)

Tests on Emulsion:	Test Method	Requirement	
		HFE-150P	HFE-300P
Viscosity, Saybolt Furol seconds @ 50 ºC (122 ºF), range	AASHTO T 59	50-400	50-400
Sieve test, retained on 850 µm (No. 20), % maximum	AASHTO 59 (2)	0.10	0.10
Storage Stability, 24 hours, % maximum	AASHTO T 59	1	1
Residue from Distillation to 204.4 ºC (400 ºF), % minimum	AASHTO T 59	65	65
Oil Distillate to 176.7 ºC (350 ºF), Volume of Emulsion, % maximum	AASHTO T 59	7.0	7.0
Tests on Residue from Distillation:			
Penetration, 25 ºC (77 ºF), 100 grams, 5 seconds, range in 0.1 mm	AASHTO T 49	150-300	300 +
Float Test at 60 ºC (140 ºF), seconds, minimum	AASHTO T 50	1200	1200
Ductility, 25 ºC (77 ºF), 5 cm/minute, cm, minimum	AASHTO T 51	100	N/A
Elastic Recovery by means of Ductilometer, 4 ºC (39.2 ºF), % minimum	AASHTO T 301 (3)	25	25

Notes:

(1) The introduction of polymer shall occur before emulsification.

(2) Distilled water shall be used. Two percent sodium oleate solution will not be accepted.

(3) Testing shall be performed on residue by distillation. Testing on residue by oven evaporation will not be accepted.

TABLE 1005-4
RECYCLING AGENTS

Tests On Recycling Agent	Test Method	Requirement							
		RA-1		RA-5		RA-25		RA-75	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity: 140°F, centistokes	AASHTO T 201	100	200	200	800	1000	4000	5000	10000
Flash Point: Cleveland Open Cup, °F, minimum	AASHTO T 48	340		375		425		450	
Saturate by weight: %	ASTM D2007		30		30		30		30
Test on Residue: Weight Change, %	AASHTO T 240		6.5		4		3		2
Viscosity Ratio: (1)			3		3		3		3

Notes:

(1) Viscosity Ratio:

$$\frac{\text{Viscosity of residue at 140 °F, centistokes}}{\text{Viscosity of recycling agent at 140 °F, centistokes}}$$

TABLE 1005-5
EMULSIFIED RECYCLING AGENTS

Tests on Emulsified Recycling Agent	Test Method	Requirement			
		ERA-1	ERA-5	ERA-25	ERA-75
Viscosity: Saybolt Furol, 77 °F, seconds range	AASHTO T 59	15 - 40	15 - 100	15 - 100	15 - 100
Miscibility	AASHTO T 59	Passes	Passes	Passes	Passes
Sieve Test: %, maximum	AASHTO T 59 (1)	0.10	0.10	0.10	0.10
Particle Charge	AASHTO T 59	Positive	Positive	Positive	Positive
Residue: (2) Residue, %, minimum	(3)	60	60	60	60

Notes:

(1) Distilled water shall be used. Two percent sodium oleate solution will not be accepted.

(2) Residue will be obtained in accordance with the requirements of Arizona Test Method 504 and shall conform to the requirements specified in Table 1005-4.

(3) Residue by evaporation may be determined in accordance with the requirements of Arizona Test Method 512; however, in case of dispute, AASHTO T 59 will be used.

TABLE 1005-6
OTHER REQUIREMENTS

Grade of Asphalt Specification Designation	Range of Temperatures for Application by Spraying, °F (Not applicable for Plant Mixing)	Range of Aggregate Temperatures for Plant Mixing, °F	Basis of Conversion, Average Gallons Per Ton at 60 °F
Paving Asphalt	275 - 400	------	
PG 76-XX			232
PG 70-XX			233
PG 64-XX			235
PG 58-XX			236
PG 52-XX			238
PG 76-22 TR+			229
PG 70-22 TR+			230
PG 64-28 TR+			231
PG 76-22 PM			231
PG 70-22 PM			232
PG 64-28 PM			233
Liquid Asphalt			
MC-70	105 - 175	90 - 155	253
MC-250	140 - 225	125 - 200	249
MC-800	175 - 225	160 - 225	245
MC-3000	215 - 290	200 - 260	241
Emulsified Asphalt		-----	240
RS-1	70 - 140		
CRS-1	125 - 185		
RS-2	125 - 185		
CRS-2	125 - 185		
CRS-2P	125 - 185 (1)		
SS-1	70 - 160		
CSS-1	70 - 160		
HFE-150P	-----		
HFE-300P	-----		
Emulsified Asphalt (Special Type)	70 - 160	-----	240
Recycling Agent (RA-1, RA-5, RA-25, RA-75)	-----	-----	240
Emulsified Recycling Agent (ERA-1, ERA-5, ERA-25, ERA-75)	70 - 160	-----	240

Note:

(1) Or as directed by the Engineer.

SECTION 1006 PORTLAND CEMENT CONCRETE:

1006-1 General Requirements:

Portland cement concrete shall consist of a mixture of hydraulic cement, fine aggregate, coarse aggregate, and water. It may also contain chemical admixtures, additives, and supplementary cementitious materials meeting the requirements herein.

The contractor shall determine the mix proportions and shall furnish concrete which conforms to the requirements of the specifications. All concrete shall be sufficiently workable, at the slump proposed by the contractor within the specified range, to allow proper placement of the concrete without segregation, bleeding, or incomplete consolidation. It shall be the responsibility of the contractor to proportion, mix, place, finish, and cure the concrete properly in accordance with the requirements of the specifications.

1006-2 Materials:

1006-2.01 Cementitious Material:

(A) General:

Cementitious material is defined as an inorganic material or a mixture of inorganic materials that sets and develops strength by chemical reaction with water by formation of hydrates and is capable of doing so under water. In this specification, cementitious materials are defined as hydraulic cement (Portland cement, Portland-pozzolan cement or Portland-limestone cement) and supplementary cementitious materials (fly ash, natural pozzolan, or silica fume).

(B) Hydraulic Cement:

Hydraulic cement shall consist of Portland cement, Portland-pozzolan cement or Portland-limestone cement.

Portland cement shall conform to the requirements of ASTM C150 for Type II, III, or V, and shall not contain more than 0.60 percent total equivalent alkalies.

Portland-pozzolan cement shall conform to the requirements of ASTM C595 for blended hydraulic cement with moderate sulfate resistance, Type IP (MS).

Cement of different types or brands shall not be intermingled or used in the same batch. The contractor shall provide suitable means for storing and protecting the cement against dampness. Cement which has become partially set or which contains caked lumps shall not be used.

The use of either sacked cement or bulk cement is permissible. The use of fractional bags of sacked cement will not be permitted unless the contractor elects to weigh the cement into each batch.

Portland-limestone cement shall conform to the requirements of ASTM C595 for blended hydraulic cement with moderate sulfate resistance, Type IL (MS).

(C) Supplementary Cementitious Materials:

(1) General:

Supplementary cementitious materials may be used in addition to hydraulic cement. Supplementary cementitious materials shall be approved prior to their use. When either moderate or high sulfate resistant concrete is specified in the Special Provisions, the proposed hydraulic cement/supplementary cementitious material blend shall be tested for sulfate expansion in accordance with ASTM C1012. When moderate sulfate resistance is specified, the maximum expansion shall be 0.10 percent at six months. When high sulfate resistance is specified, the maximum expansion shall be 0.05 percent at six months or 0.10 percent at one year.

(2) Fly Ash and Natural Pozzolan:

Fly ash and natural pozzolan shall conform to the requirements of ASTM C618 for Class C, F, or N.

(3) Silica Fume:

Silica fume shall conform to the requirements of ASTM C1240. Certification of silica fume will be based on a Certificate of Compliance conforming to the requirements of Subsection 106.05 of the specifications submitted for each lot of silica fume.

(D) Acceptance of Cementitious Materials:

The certification and acceptance of cementitious materials will be on the basis of the materials originating from an Approved Materials Source. Approved Materials Sources Lists for cementitious materials are maintained by the ADOT Materials Group, Structural Materials Testing Section.

Source approval of hydraulic cement, fly ash, and natural pozzolan producers/suppliers will be based on monthly submittals to the ADOT Materials Group, Structural Materials Testing Engineer, at cert@azdot.gov. The following documentation shall be submitted:

(1) A Certificate of Compliance which lists the lots produced during that month; and

(2) A separate Certificate of Analysis for each lot shown on the corresponding Certificate of Compliance for that month.

1006-2.02 Water:

Water shall meet the requirements of ASTM C1602, except that it shall contain no more than 1,000 parts per million of chlorides as Cl and no more than 1,000 parts per million of sulfates as SO4. The water used shall be free of injurious amounts of oil, acid, alkali, clay, vegetable matter, silt, or other harmful matter. Potable water obtained from public utility distribution lines will be acceptable.

1006-2.03 Aggregates:

(A) General Requirements:

When concrete is to be placed at elevations above 4,500 feet, the fine aggregate and the coarse aggregate shall be subjected to five cycles of the sodium sulfate soundness test, and the weighted percentage loss determined separately for each, in accordance with the requirements of ASTM C88. The weighted percentage loss determined for each shall not exceed 10 percent. Tests for soundness may be waived when aggregates from the same source have been approved and the approved test results apply to the current production from that source.

Mill tailings or material from mine dumps shall not be used in the production of fine or coarse aggregate.

The following test methods may be used to evaluate the quality of aggregates for concrete:

TABLE 1006-1
Test Methods for Quality of Aggregates

Sampling	AASHTO R 90
Reducing field samples to testing size	AASHTO R 76
Potential for Alkali Silica Reaction (ASR)	ASTM C1260, C1567, or ASTM C1293
Clay lumps and friable particles	AASHTO T 112
Lightweight particles (Specific gravity less than 2.0)	AASHTO T 113 (See Note1)
Organic impurities	AASHTO T 21
Aggregate gradation	AASHTO T 11, T 27
Soundness (Sodium Sulfate)	ASTM C88
Mortar Strength	AASHTO T 71 (See Note1)
Sand equivalent	AASHTO T 176
L.A. abrasion	AASHTO T 96
Fractured Coarse Aggregate Particles	AASHTO T 335

TABLE 1006-1 Test Methods for Quality of Aggregates
Note: (1) AASHTO T 113 and T 71 are modified as specified in Subsections 1006-2.03(B) and 1006-2.03(C) of the specifications.

(B) Fine Aggregate:

Fine aggregate shall be a natural or manufactured sand, or other approved inert material with similar characteristics, composed of clean, hard, strong, durable, uncoated particles. The aggregate shall be washed and shall conform to the requirements of AASHTO M 6, with the following exceptions:

The amount of deleterious substances in the washed fine aggregate shall not exceed the following limits by dry weight, when tested in accordance with the following test methods:

TABLE 1006-2 Deleterious Substances in Fine Aggregate		
Clay lumps and friable particles	AASHTO T 112	0.5%
Lightweight particles (Specific gravity less than 2.0)	AASHTO T 113 (Except that the percent of lightweight particles shall be reported to the nearest 0.01%.)	1.25% (0.25% Max. Coal and Lignite*)
Note: *Only material that is brownish-black, or black, shall be considered coal or lignite.		

Fine Aggregate shall meet the following gradation requirements when tested in accordance with AASHTO T 11 and AASHTO T 27.

TABLE 1006-3 Gradation of Fine Aggregate	
Sieve Size	**Percent Passing**
3/8 in.	100
No. 4	95 - 100
No. 16	45 - 80
No. 50	0 - 30
No. 100	0 - 10
No. 200	0 - 4.0

Fine aggregate shall have a sand equivalent value of not less than 75. Fine aggregates shall be subjected to testing under AASHTO T 21 for organic impurities. Fine aggregate producing a color darker than the standard color shall be rejected unless the material passes the mortar strength requirements specified in the following paragraph:

Fine aggregate not meeting the requirements for organic impurities shall be made into mortar and subjected to testing in accordance with AASHTO T 71, except that the mortar shall develop a compressive strength at seven and 28 days of not less than 90 percent of that developed by a mortar prepared in the same manner with the same Type II cement and graded sand conforming to the requirements of ASTM C778.

(C) Coarse Aggregate:

Coarse aggregate shall consist of crushed stone, gravel, crushed gravel, or other approved inert material of similar characteristics, including cinders when specified, having hard, strong and durable pieces free of clay and other deleterious substances. The aggregate shall be washed. The aggregate gradation, when tested in accordance with AASHTO T 11 and AASHTO T 27, shall conform to the appropriate size designation of AASHTO M 43.

The amount of deleterious substances in the washed coarse aggregate shall not exceed the following limits by dry weight, when tested in accordance with the following test methods, except as noted:

TABLE 1006-4
Deleterious Substances in Coarse Aggregate

Clay lumps and friable particles	AASHTO T 112	0.3%
Lightweight particles (Specific gravity less than 2.0)	AASHTO T 113 (Except that the percent of lightweight particles shall be reported to the nearest 0.01%.)	1.25% (0.25% Max. Coal and Lignite*)
Material passing No. 200 sieve	AASHTO T 11, T 27	1.0%

Note:

* Only material that is brownish-black, or black, shall be considered coal or lignite.

The percent of wear of coarse aggregate at 500 revolutions, when tested in accordance with the requirements of AASHTO T 96, shall not exceed 40. The percent of one face fractured coarse aggregate particles shall be at least 30 when tested in accordance with the requirements of AASHTO T 335.

1006-2.04 Admixtures and Additives:

(A) General Requirements:

A list of approved admixtures and additives is maintained on the Department's Approved Products List (APL). Copies of the most recent

version of the APL are available on the Department's website from the ADOT Research Center through its Product Evaluation Program. Admixtures and additives other than those listed on the APL may be considered for use as specified in Subsection 106.14 of the specifications.

Certificates of Compliance shall be submitted which clearly state the time period in which the production of the product meets the appropriate ASTM standard and that formulation of the product has not changed during the stated time period. The time period shall be limited to 12 months prior to the date of signature on the certificate. The certificate shall be submitted to the ADOT Materials Group, Structural Materials Testing Section, and retained for record.

Concrete admixtures and additives shall be uniform throughout their use in the work. All concrete admixtures and additives shall be stored in suitable containers in accordance with the manufacturer's recommendations. All liquid admixtures shall be protected from freezing. Liquid admixtures that have frozen shall not be used. If more than one admixture is used, the admixtures shall be compatible with each other so that the desired effects of all admixtures used are realized.

Admixtures and additives having a chloride concentration of 10,000 parts per million (1 percent by weight of the admixture) or less, as determined in accordance with Arizona Test Method 738 or Test Method BS EN 480-10:2009, are acceptable unless otherwise specified. Calcium chloride as a separate admixture shall not be used. At no time shall materials with chlorides be incorporated into any precast bridge members, precast concrete product, or concrete pipe product.

(B) Chemical Admixtures:

Air-entraining admixtures shall conform to the requirements of ASTM C260.

Water reducing, retarding, hydration stabilizing, and accelerating admixtures shall conform to the requirements of ASTM C494 for the appropriate type.

Specific performance admixtures for precast items, patching materials, or other products shall also conform to the requirements of ASTM C494, including data to substantiate the specific performance characteristics.

(C) Additives:

Pigments incorporated into the approved concrete mix design for integrally colored concrete shall meet the requirements of ASTM C979.

Fibers incorporated into the approved concrete mix shall meet the requirements of ASTM C1116. The specific type, size, and quantity of fiber shall be determined by the mix designer.

Micro fiber additive may be used for plastic shrinkage control, subject to approval by the Engineer.

1006-3 Design of Mixtures:

1006-3.01 Design Criteria:

Portland cement concrete shall conform to the requirements specified in Table 1006-5 for each of the classes listed therein. Unless otherwise specified, the cementitious material content shall be as shown:

TABLE 1006-5
Design Criteria

Class of Concrete	Minimum 28-Day Compressive Strength Required: psi (ASTM C39)	Cementitious Material Content: Lbs. per Cu Yd. Minimum-Maximum	Maximum Water-Cementitious Material Ratio (w/cm): Lb./Lb.	Slump Range: Inches
B	2,500	470 – 658	None	Chosen by contractor
S	2,500	520 – 752	0.55	
	3,000			
	3,500			
	4,000			
	4,500	564 – 752	0.50	
	Greater than 4,500	564 – 800	0.45	
P	4,000	564 – 658	None	0 – 4.5
H	High performance concrete as specified in project special provisions.			

(A) Supplementary Cementitious Material Limitations and Requirements:

Supplementary cementitious materials (fly ash, natural pozzolan, or silica fume) conforming to the requirements of Subsection 1006-2.01 of the specifications may be used, as specified in the paragraphs below:

(1) When Portland cement is used, a maximum of 25 percent, by weight of the cementitious material, may be an approved fly ash or natural pozzolan, except as specified in paragraphs (4), (5), and (6) below;

(2) When Portland pozzolan cement [Type IP (MS)] is used, fly ash or natural pozzolan is not allowed, except as specified in paragraphs (4), (5), and (6) below;

(3) When silica fume is used, a maximum of 10 percent, by weight of the cementitious materials, may be used;

(4) When a compressive strength greater than 4,500 pounds per square inch is required, supplementary cementitious materials may be added in excess of the maximum cementitious material content. Fly ash or natural pozzolan may exceed 25 percent and silica fume may exceed 10 percent, by weight of the cementitious material, if approved by the Engineer;

(5) When increased sulfate resistance is specified, the required amount of fly ash or natural pozzolan shall be incorporated into the concrete and may exceed 25 percent, by weight of the cementitious material; and

(6) For Class S concrete used in bridge decks, a minimum of 20 percent, by weight of the cementitious material, shall be an approved Class F fly ash or natural pozzolan, unless otherwise approved by the Engineer.

(B) Alkali-Silica Reactivity Limitations and Requirements:

For any concrete mix, other than for precast or prestressed bridge members, with a Portland cement content greater than 545 pounds per cubic yard, one of the options specified in the paragraphs below for the mitigation of a potential alkali silica reaction (ASR) shall be used:

(1) A minimum of 20 percent Class F fly ash or natural pozzolan, by weight of the cementitious material, shall be used;

(2) Instead of using Portland cement, Type IP (MS) Portland-pozzolan cement with a Class F fly ash or natural pozzolan content of at least 20 percent, by weight of the cementitious material, shall be used;

(3) Limit the total equivalent alkalies to a maximum of 3.00 pounds per cubic yard of concrete, when calculated as follows:

$$\begin{bmatrix}\text{Pounds of total}\\ \text{alkali per cubic}\\ \text{yard of concrete}\end{bmatrix} = \frac{\begin{pmatrix}\text{Pounds of Portland}\\ \text{cement per cubic}\\ \text{yard of concrete}\end{pmatrix} \times \begin{pmatrix}\text{Equivalent alkalies (\%)}\\ \text{in Portand cement}\end{pmatrix}}{100}$$

(4) Introduce a lithium nitrate admixture, which has been approved by the Engineer, at a minimum dosage of 0.55 gallons of 30 percent lithium nitrate solution per pound of total equivalent alkalies per cubic yard of concrete. The required amount of lithium nitrate is calculated as follows:

$$\begin{bmatrix}\text{Required gallons}\\ \text{of 30 percent}\\ \text{lithium nitrate}\\ \text{solution}\end{bmatrix} = \frac{\begin{pmatrix}\text{Pounds of}\\ \text{Portland cement}\\ \text{per cubic yard}\\ \text{of concrete}\end{pmatrix} \times \begin{pmatrix}\text{Equivalent alkalies (\%)}\\ \text{in Portand cement}\end{pmatrix}}{100} \times (0.55)$$

(5) The coarse aggregate and the fine aggregate shall be tested separately in accordance with ASTM C1260 to determine the potential for alkali silica reaction (ASR). When aggregates show the potential for ASR, as indicated by expansions of 0.10 percent or greater at 16 days after casting, sufficient mitigation for the expansion shall be determined in accordance with ASTM C1567. The use of fly ash or natural pozzolan may exceed 25 percent, by weight of the cementitious material when used to mitigate the potential for ASR.

(C) Class B and Class S Concrete Slump Limitations and Requirements:

The proposed slump for Class B and Class S concrete shall be chosen by the contractor. The permissible variation for the proposed slump shall be as specified in Subsection 1006-7.03 of the specifications. Concrete at the proposed slump shall be sufficiently workable to allow proper placement without harmful segregation, bleeding, or incomplete consolidation.

(D) High Performance Concrete Limitations and Requirements:

For Class H concrete, if the maximum cementitious material content is exceeded in order to achieve high early strength requirements, and if required by the Engineer, the mix design shall be accompanied by shrinkage testing demonstrating that shrinkage is less than 0.04 percent

when tested in accordance with ASTM C157. However, the conditioning period shall be modified to consist of an initial seven day wet curing period followed by a 21 day dry curing period.

(E) Air Entrainment Requirements:

Air-entraining admixtures are required for all classes of concrete placed at an elevation of 3,000 feet or above and may be used in other situations at the contractor's discretion. For air-entrained concrete placed at an elevation of 3,000 feet or above, a specific air content target shall be established in the mix design with a value within the range of the appropriate criteria from Table 1006-10 in Subsection 1006-7.03 (A) of the specifications.

No air-entrainment will be required for minor precast structures, precast pipe, and precast, prestressed structural members supporting a concrete deck slab or impervious overlay. Also, no air-entrainment is required for any precast items constructed using the dry pack or no-slump method.

(F) Water-Reducing Admixtures:

Unless specifically required, water-reducing admixtures may be used at the option of the contractor.

(G) Coarse Aggregate Size Determination:

The coarse aggregate size designation for Class S or Class B concrete shall be chosen by the contractor and approved by the Engineer and shall conform to the size designation and grading requirements of AASHTO M 43. In choosing the size designation, the maximum size of coarse aggregate shall not be larger than 1/5 of the narrowest dimension between the sides of adjacent forms, or 2/3 of the minimum clear spacing between reinforcing bars, or 2/3 of the minimum clear spacing between reinforcing bars and the sides of adjacent forms, or 1/3 of the depth of the slab, whichever is least. If two or more stockpiles are utilized to manufacture an AASHTO M 43 size designation, at the time of proportioning for mixing, the aggregate from each stockpile shall be measured by weight and proportioned so that the resulting mixture of coarse aggregate meets the requirements for the chosen size designation.

Coarse aggregate for Class P concrete used to construct Portland cement concrete pavement without load transfer dowels shall be separated into two or more stockpiles. At the time of proportioning for mixing, the aggregate from each stockpile shall be measured by weight and proportioned so that the resulting mixture of coarse aggregate meets the requirements for size designation No. 467, as specified in AASHTO M 43. Coarse aggregate for Class P concrete placed in pavement ramp tapers not exceeding a width of 10 feet and in pavement gore areas may be size designation No. 57, as specified in AASHTO M 43. The use of

size designation No. 57 coarse aggregate may be used in concrete placed in other inaccessible pavement areas when approved in writing by the Engineer.

Coarse aggregate for Class P concrete used to construct Portland cement concrete pavement with load transfer dowels and adjacent shoulders shall meet the requirements for size designation No. 57, as specified in AASHTO M 43.

1006-3.02 Mix Design Submittal Procedures:

At least two weeks prior to the appropriate concreting operation, the contractor shall submit concrete mix designs to the Engineer for review and approval. More than one mix design for each class of concrete and each strength of Class S concrete may be submitted for approval provided specific items and locations of intended uses accompany each mix design. For mix designs without historical data in ADOT files, the contractor shall substantiate the mix design(s) by furnishing sufficient mix history or trial batch testing data as specified in Subsection 1006-3.03 of the specifications and providing all details of the mixtures proposed for use. The contractor shall submit all mix designs with a separate cover sheet(s) which includes the following information:

(A) Cover Sheet:

(1) Project name;
(2) Project number;
(3) ADOT project number;
(4) Contractor;
(5) Subcontractor (if applicable);
(6) Material supplier; and
(7) A list of the submitted mix designs identified by product code, design strength, batch plant, class, and intended use(s).

If supplied by a commercial ready-mix supplier, the batch plant number and address shall be provided on the cover sheet as well as the date of the most recent batch plant certification and the name of the inspecting and certifying organization or agency.

(B) Mix Designer:

Mix designs shall be prepared by or under the direct supervision of, and signed by a person having both experience in the development of mix designs, including the respective type of concrete, and satisfying one of the following criteria:

(1) Registered Professional Engineer;
(2) Certified National Institute for Certification in Engineering Technologies (NICET) Level III Technician or higher;

(3) Certified National Ready Mix Association (NRMCA) Level 3 Concrete Technologist; or
(4) Certified American Concrete Institute (ACI) Concrete Laboratory Testing Technician Level 2 or Grade II

Mix designs for precast or prestressed concrete shall be prepared by or under the direct supervision of, and signed by, a Registered Professional Engineer or a PCI Quality Control Technician/Inspector Level II or higher.

(C) Mix Design Submittal Requirements:

Concrete mix designs shall be proportioned on the basis of a cubic yard of concrete. The complete solid volume mix design(s) submitted for approval shall be provided to the Engineer by the contractor and shall include all of the following:

(1) Product Code;
(2) ADOT project number;
(3) Plant Identification and Location;
(4) Class of Concrete;
(5) Design strength and age;
(6) Design air content and range (±);
(7) Design slump range for Class P (as specified in Table 1006-5) or design slump and permissible variation (as specified in Subsection 1006-7.03 of the specifications) for Class S and Class B concrete;
(8) Design spread and permissible variation for self-consolidating concrete (SCC) (as specified in Subsection 1006-4.05(E) of the specifications);
(9) Design water-cementitious materials ratio;
(10) Design unit weight in pounds per cubic foot;
(11) Name and type of each material including admixtures and additives;
(12) Supplier of each material including admixtures and additives;
(13) Source of cementitious materials, water, and aggregates including the associated commercial materials (CM) source number(s);
(14) Weight of each material measured to the nearest pound;
(15) Specific gravity of each material (determined within last 12 months) to the nearest thousandth;
(16) Volume of each material measured to the nearest hundredth of a cubic foot;
(17) Dosage rate of each chemical admixture or additive or manufacturer-recommended dosage range when applicable;
(18) Total volume measured to the nearest hundredth of a cubic foot;
(19) Total weight per cubic yard measured to the nearest pound; and

(20) Printed name and signature of the individual responsible for development of the mix design.

A single mix design product code may include multiple sources of cement, fly ash, natural pozzolan, and silica fume. When multiple sources of material are used under one product code, documentation shall be provided which shows similar performance using materials from each source. Multiple sources of material shall be listed on the mix design as alternative sources.

1006-3.03 Approval of Concrete Mix Designs:

All mix designs shall be approved by the Engineer prior to use. All mix designs for precast or prestressed concrete shall be approved by the Materials Structural Testing Section prior to use. Mix designs meeting the criteria herein and identified as one of the following will be considered for approval:

A mix design that has been previously approved or used successfully on an ADOT project within the past 24 months and is on file with the Department.

A mix design similar to that specified that has been used successfully on a non-ADOT project and sufficient mix history no older than 24 months shall be included with the mix design submittal. The mix history shall include dates placed, compressive strength test records, and other pertinent data.

A new mix design that does not meet the criteria for a previously used mix design requires a trial batch from either the field batch plant or an ADOT approved testing laboratory.

In no case shall the approval of a mix design relieve the contractor of the responsibility for the results obtained by the use of such approved mix design.

(A) Previously Used Mix Design Approval:

(1) Previously Used on ADOT Projects:

Mixtures having been ADOT approved or used previously with satisfactory compressive strength history within the past 24 months may be acceptable provided all of the following apply:

(a) The mix code, design slump, and air content have not changed, and the water-cementitious materials ratio has not increased;

(b) The coarse aggregate size designation(s) and source remain unchanged and the total coarse aggregate quantity has not changed by more than 5 percent;

(c) The fine aggregate source remains unchanged and the quantity has not changed by more than 5 percent;

(d) The source and type of each cementitious material remains unchanged and the quantity of each has not changed by more than 2 percent;

(e) The quantity of water has not changed by more than 2 percent;

(f) Coarse and fine aggregate specific gravities have been measured and updated within the last 12 months; and

(g) The dosage of chemical admixtures remain within manufacturer's recommended ranges.

(2) Previously Used on Non-ADOT Projects:

When submitting a concrete mix used successfully on a non-ADOT project, mix history shall be required for consideration and approval of the mix. Using strength test records from an ADOT approved laboratory, which are not more than 24 months old, a sample standard deviation (ss) may be used to establish the required over-design. Test records shall comply with the following criteria:

(a) Representative of materials, quality control procedures, and conditions similar to those expected on the project;

(b) Representative of concrete produced to meet a compressive strength, or strengths, within 1000 pounds per square inch below or 1000 pounds per square inch above the specified design compressive strength;

(c) Shall include the date, compressive strength, slump, air content (when applicable), and calculated results from Table 1006-6 and Table 1006-7; and

(d) Consist of at least 15 consecutive compressive strength tests that span a period of not less than 45 days. If the test record consists of at least 30 consecutive tests, the sample standard deviation (ss) of those tests is used. If the test record consists of 15 to 29 consecutive tests, the standard deviation of

those tests shall be modified in accordance with Table 1006-6.

TABLE 1006-6
Standard Deviation Modification Factor

No. of tests *	Modification factor for sample standard deviation (k)
< 15	Minimum 20% over-design
15	1.16
20	1.08
25	1.03
30 or more	1.00

Note:

* For 15 to 29 tests, interpolate for intermediate number of tests.
k = Modification factor (multiplier) by which ss shall be multiplied to be used to determine the required minimum over-design compressive strength, f 'cr, in Table 1006-7.

The required minimum over-design compressive strength shall be determined by the equations shown in Table 1006-7.

Table 1006-7
Over-Design Compressive Strength Equations

Specified design compressive strength, psi	Required minimum over design compressive strength, psi
f 'c ≤ 5000	Use the larger value computed from these two equations: $f'_{cr} = f'_c + 1.34k \times s_s$ $f'_{cr} = f'_c + 2.33k \times s_s - 500$
f 'c > 5000	Use the larger value computed from these two equations: $f'_{cr} = f'_c + 1.34k \times s_s$ $f'_{cr} = 0.90 f'_c + 2.33k \times s_s$

Legend:

f 'c= Specified design compressive strength.

f'cr= Required minimum over-design compressive strength

s_s= Sample standard deviation

k= Modification factor from Table 1006-6 if applicable

To be considered for approval by the Engineer, the average strength of the provided test data shall be greater than f'cr, and the mix history shall be from a mix deemed to be sufficiently representative of the materials and proportions proposed for use in the submitted mix design.

(B) New Mix Design Approval:

The over-design requirement for new mix designs shall be a minimum of 20 percent of the specified design compressive strength and shall be substantiated by trial batches. Trial batch results may be from laboratory trial batches or full-scale trial batches.

(1) Laboratory trial batches are defined as "proportionally reduced quantities of the materials that are to be used in production, mixed in a portable or laboratory concrete mixer at an ADOT Approved Laboratory". Such trial batches shall be overseen and verified by a Professional Engineer with experience in concrete mix designs.

(2) Full-scale trial batches are defined as "utilizing the materials, mixing equipment, and procedures that are the same as those to be used in production." Full-scale trial batches shall consist of at least 4 cubic yards of concrete and shall be overseen and verified by a Professional Engineer with experience in concrete mix designs. The Engineer reserves the right to witness the full-scale trial batch activities.

(3) All trial batches for precast or prestressed concrete will be observed, tested, and documented by the ADOT Materials Structural Testing Section and approved by the Engineer.

Trial batches shall have slump results within the range specified for the proposed work. When air-entrained concrete is specified, the air content shall be in compliance with the specified requirements. Compressive strength testing samples shall be cured and tested by an ADOT Approved Laboratory.

Trial batch test results, prior to the specified compressive strength acceptance age, may be used for early approval if the compressive strength test results meet the minimum over-design requirement for the specified acceptance age.

When approved by the Engineer, concrete from trial batches may be used in the work at locations where concrete of a lower strength is required and such concrete shall meet the requirements of the class of concrete at that location.

1006-4 Concrete Production:

1006-4.01 General Requirements:

The contractor may obtain concrete for each class of concrete and for each strength of Class S concrete from a source approved by the Engineer in lieu of establishing a batch plant at the project site.

(A) Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) of the specifications when specified in the Special Provisions.

At the weekly meeting, the contractor shall be prepared to explain and discuss how the following processes will be employed.

(a) Aggregate Production, including crusher methods, pit extraction, and washing.

(b) Stockpile Management, including stacking methods, separation technique, plant feed technique, stockpile pad thickness, and segregation prevention.

(c) Mixing and Transport, including mixing time and revolutions, water and concrete temperature, integrity of mixing equipment, sight glass for water, slump meters, batch ticket, and travel time.

(d) Proportioning, including scale calibration, water added, water meter moisture correction, and bin loading.

The contractor shall obtain samples and perform the tests specified in the following table:

CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Fine Aggregate for PCC (Class S or Class P)			
Gradation	AASHTO T 11, T 27	Crusher Belt or Stockpile	1 per 750 CY of Concrete
Sand Equivalent	AASHTO T 176	Crusher Belt or Stockpile	1 per 750 CY of Concrete
Coarse Aggregate for PCC (Class S or Class P)			
Gradation	AASHTO T 11, T 27	Crusher Belt or Stockpile	1 per 750 CY of Concrete
Class S Portland Cement Concrete			
Entrained Air	AASHTO T 152	At Point of Discharge	1 per 40 CY of Concrete
Slump	AASHTO T 119	At Point of Discharge	1 per 40 CY of Concrete

1006-4.02 Measuring Materials:

(A) Cementitious Material:

Cementitious material shall be measured by weight. When supplementary cementitious materials are used in the concrete mixtures, the cumulative weight is permitted to be measured with hydraulic cement, and on a scale which is separate and distinct from those used for other materials. The weight of the hydraulic cement shall be measured before supplementary cementitious materials. When the quantity of cementitious material exceeds 30 percent of the full capacity of the scale, the measured quantity of the hydraulic cement shall be within 1 percent of the required weight, and the cumulative measured quantity of hydraulic cement plus supplementary cementitious materials shall also be within 1 percent of the required cumulative weight at each intermediate weighing. For smaller batches of less than 30 percent of the full capacity of the scale, the measured quantity of the hydraulic cement and the measured cumulative quantity of hydraulic cement plus supplementary cementitious materials used shall not be less than the required amount or more than 4 percent in excess of the required amount. In specific cases, cementitious materials in bags may be used with prior approval of the Engineer.

(B) Water:

Mixing water is defined as the total amount of water in a batch less the water absorbed by the aggregates and is used to calculate the water-cementitious materials ratio (w/cm). Mixing water shall consist of batch water (water weighed or metered at the plant), ice, free moisture on the aggregates, wash water retained in the mixer before batching, and water added at the jobsite in accordance with Subsection 1006-7.03 of the specifications. The batch water shall be measured by mass or volume to an accuracy of ± 1.5 percent of the target batch water. If the quantity of water introduced from admixtures increases the water-cementitious materials ratio by more than 0.01, it shall also be included in the total amount of mixing water. In the case of truck mixers, any wash water retained in the drum for use in the next batch of concrete shall be measured; if this proves impractical the wash water shall be discharged before loading the next batch of concrete. The total quantity of mixing water shall not exceed the mix design target quantity by more than 3 percent.

(C) Aggregates:

Aggregate shall be measured by weight. The quantity of aggregate weighed shall be the required dry weight plus the total moisture content (absorbed and surface) of the aggregate.

When aggregates are measured in an individual or cumulative weigh batcher and the required weight of aggregate is equal to or greater than 30 percent of the scale capacity, the total quantity of aggregate shall be within 2 percent of the required weight. In addition, if a cumulative weigh batcher is used, the quantity of aggregate at each successive weighing shall be within 2 percent of the required weight.

When aggregates are measured in individual or cumulative weigh batchers, and the required intermediate or final weight is less than 30 percent of the scale capacity, the aggregate weight shall be within 3 percent of the required weight.

(D) Admixtures and Additives:

Chemical admixtures in powdered form or other additives in solid form (such as fibers or color) shall be measured by weight. Liquid chemical admixtures shall be batched by weight or volume. Admixtures measured by either weight or volume, shall be batched with an accuracy of ± 3 percent of the total required amount. For liquid chemical admixtures, dispensers of a mechanical type capable of adjustment for variation of dosage, and of simple calibration, are required, unless approved by the Engineer.

1006-4.03 Batching of Concrete:

(A) General Requirements:

Concrete may be batched in a standard batch plant or a central mixing plant. The plant may be situated at the project site, or it may be located off-site or at a commercial supplier. All materials utilized in the batching of concrete shall be from an approved source or supplier.

(B) Concrete Plant Requirements:

(1) All Concrete Plants:

The handling and storage of concrete aggregate shall be such as to maintain them at or above a saturated-surface-dry (SSD) moisture condition and to minimize segregation or the intermixing and contamination with foreign materials. The Engineer may require that aggregate be stored separately. Different sizes of aggregate shall be separated by bulkheads or stored in separate stockpiles sufficiently removed from each other to prevent the materials from becoming intermixed. When aggregates are stored on the ground, the sites for the stockpiles shall be level and clear of all vegetation. The bottom 1 foot layer of aggregate shall not be disturbed or used.

All concrete batch plants and batching operations shall have been inspected and satisfy applicable criteria before being used to produce concrete. As an alternative to an ADOT inspection of the concrete batch plants and batching operations, the supplier may submit certification of their concrete production facilities from NRMCA or Arizona Rock Products Association (ARPA) to the Engineer. Concrete batch plants shall be inspected a minimum of once every two years. ADOT may inspect concrete batch plants at any time.

Each batch plant shall be equipped to control the time when the water enters the mixer during the mixing cycle. Batch and mixing time shall be

calculated from the time cementitious material is first combined with water or aggregates.

(2) Project Specific Plants for Class P Concrete:

The handling and storage of concrete aggregate for Class P concrete at the job site or a project specific plant site shall be such as to minimize segregation. Stockpiles shall be neat and regular in form and shall occupy as small an area as possible.

Contamination of concrete aggregate for Class P concrete by contact with the ground at the job site shall be prevented. The contractor shall take the necessary measures to prevent such contamination. Such preventive measures include placing aggregate on hardened surfaces consisting of Portland cement concrete, asphaltic concrete, or cement treated material.

The contractor shall maintain at least two full days' worth of production of fine and coarse aggregate stockpiled at the batch plant for Class P concrete prior to starting and throughout the duration of Portland cement concrete paving operations. This requirement is waived for the last two days of production.

(C) Concrete Plant Operation and Documentation:

Concrete batch plants shall be operated in accordance with the manufacturer's guidelines and recommendations. The amount of material measured for each batch of concrete shall not exceed the plant's rated capacity. A record of certification current to within the last six months for all scales, balances, load cells, or water measuring systems used in the production of concrete shall be maintained at the batch plant and shall be made available to the Engineer upon request.

When requested by the Engineer, the contractor shall supply a separate record for each batch of concrete which shows the batch weight or quantity of each individual ingredient. The amount of water introduced into the batch including that contained on the aggregate shall be verifiable.

(D) Concrete Ticketing Systems:

For each class of concrete and each strength of Class S concrete, except for Class P concrete produced in a batch plant at the project site and used exclusively for Class P work, the contractor shall furnish a delivery ticket for each batch of concrete, including any trial batches. The minimum information to be shown on each delivery ticket shall be:

(1) Date;
(2) Time batched;
(3) Truck identification number;
(4) Name or identification of batch plant;

(5) Name of contractor;
(6) Name and location of project;
(7) Quantity of concrete;
(8) Mix design product code; and
(9) Amount of permissible additional water to meet the design water-cementitious material ratio

Any manually added additives or admixtures previously approved by the Engineer to be added to an existing mix design, which cannot go through the plant or batching system, shall be recorded and shown on the delivery ticket.

In addition, the number of revolutions that the concrete has been mixed at mixing speed in a truck mixer shall be noted on the delivery ticket.

An authorized representative of the contractor shall be responsible for each delivery ticket and shall sign each delivery ticket accepting the contractor's responsibility for the concrete. The representative shall furnish a copy of the delivery ticket to the Engineer after discharge of the concrete is complete.

1006-4.04 Mixing and Transport of Concrete:

(A) General Requirements:

All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of un-dispersed cement. Equipment having components made of aluminum or magnesium alloys, which would have contact with plastic concrete during mixing and transporting, shall not be used.

(B) Mixing in a Stationary Mixer (Central Mix Plant or Drum Mix Plant):

The volume of concrete mixed per batch shall not exceed the capacity of the mixer as shown on the manufacturer's plate or documentation. No spillage of concrete is allowed during the process of mixing.

While mixing, the mixer shall be operated at the speed shown on the manufacturer's plate as the mixing speed.

The mixing time shall not be less than 60 seconds per batch for Class P concrete and the mixing time shall be increased if directed by the Engineer. The mixing time shall be not less than 60 seconds for 1 cubic yard and shall be increased 15 seconds for each additional cubic yard or fraction thereof for Class S or Class B concrete.

The mixer shall have an automatic timing device which locks the discharge equipment until the required mixing time has been completed. The mixer shall be operating at mixing speed at the time that all ingredients enter the mixer to ensure the immediate beginning of the

mixing cycle. Mixing time shall end when the discharge chute opens. The contents of the mixer shall be completely discharged before the succeeding batch is placed in the mixer.

Any concrete discharged before the mixing time is completed shall be disposed of by the contractor at no additional cost to the Department.

Central mixers shall be equipped with automatic batch meters for counting the batches for Class P concrete. The contractor shall furnish the batch count daily to the Engineer.

In the case of mixing in a central mixer, when fibers are incorporated into the concrete, mixing time and revolution rate is performed the same way as plain concrete because there is sufficient shear provided to uniformly disperse the fibers. A test or trial mixing is always recommended to ensure that the mixture supports the fiber type and dosage and that there are no problems with the batching sequence.

Mixed concrete shall be transported in truck mixers, truck agitators or in non-agitating trucks.

When truck mixers or truck agitators are used, the concrete shall be continuously agitated from the time of loading until the time of discharge. Agitation shall be by rotation of the drum at the speed shown on the manufacturer's plate as agitating speed. The truck mixer or truck agitator shall be loaded and operated within a capacity not to exceed 80 percent of the gross volume of the drum. The rate of discharge shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully opened.

Bodies of non-agitating trucks shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. If discharge of concrete is accomplished by tilting the body, the surface of the load shall be retarded by a suitable baffle. Covers shall be provided when needed for protection.

Discharge from non-agitating trucks shall be completed within 45 minutes from the time concrete is batched.

Concrete hauled in open-top vehicles shall be protected against rain. When the ambient temperature exceeds 85 degrees F the concrete shall be covered if it could be exposed to the sun for more than 30 minutes.

(C) Mixing in Truck Mixers:

All concrete truck mixers shall be inspected and satisfy applicable criteria before being used to mix and deliver concrete. As an alternative to the annual ADOT inspection of truck mixers, the trucks may be inspected in accordance with the requirements of the NRMCA and/or ARPA inspection programs. Such inspections shall be performed in

accordance with NRMCA's "Section 5 of Quality Control Manual, Section 3, Inspection & Certification of Delivery Vehicles" or ARPA's "Certification of Ready Mixed Delivery Fleet" checklist and guideline. Upon satisfactory completion of inspection, an inspection sticker shall be applied in a clearly visible location to the inside of the driver's side door of the truck, or an NRMCA card shall be readily available. Truck mixers that do not have a valid NRMCA card, or ADOT or ARPA sticker indicating the date of inspection are not allowed to supply concrete to ADOT projects. Truck mixers shall be inspected annually at a minimum and may be inspected at any time.

Each mixer shall meet the specified requirements for type and size and shall have attached in a prominent place a manufacturer's plate showing the gross volume of the mixer and the recommended speeds of the mixer for mixing and for agitating. Truck mixers shall be operated within a capacity not to exceed 63 percent of the gross volume of the drum and at speeds shown on the manufacturer's plate as mixing and agitating speeds.

Truck mixers shall be equipped with an electrically or mechanically activated revolution counter by which the number of drum revolutions may be verified. The counter shall accurately register the number of revolutions. It shall be mounted on the truck mixer or inside the truck cab, so that it may be safely and conveniently read. The revolution counter shall be reset to zero after all materials have been loaded into the drum at the plant.

Truck-mixed concrete shall be mixed entirely in the truck mixer. Mixing shall begin after the cement has been combined with either the aggregate or water. Each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum, at mixing speed, after all materials have been loaded into the drum at the plant, except that when approved by the Engineer, the maximum of 100 revolutions may be increased. Any revolving of the drum beyond the maximum number of revolutions shall be at the agitating speed.

When fibers are incorporated into the concrete, it is recommended to add the fibers in a continuous manner. A mixing speed of 10 to 12 rpm is typically used for the rate of addition in trucks. A minimum of 40 revolutions (four to five minutes) after all the fibers are added is recommended for proper mixing and dispersion of fibers in trucks.

Mixers shall be cleaned at suitable intervals. Water used for cleaning the mixer shall be discharged prior to further batching.

(D) Mixing in Volumetric Mixers:

Concrete mixing in volumetric mixers for Class S or Class B concrete shall be performed in accordance with the requirements of ASTM C685.

1006-4.05 Manufacturing Precast Items:

(A) General:

Manufacturers proposed by the contractor to manufacture precast items shall be on the "Approved Precast Concrete Products Manufacturers List" or the "Approved Precast/Prestressed Bridge Members Manufacturers List" on the Structural Materials Testing Section website. Only the manufacturers on the approved list(s) shall manufacture precast concrete products or precast bridge members for ADOT construction projects.

(B) Scheduling:

Shop drawings shall be submitted and approved as required in Subsection 105.03 of the specifications. The reviewer shall notate their full first and last name and contact phone number on the approved shop drawings. The contractor shall submit a copy of the approved shop drawings to the Structural Materials Testing Section at least five working days in advance of the start of production of the precast items. Any changes to shop drawings must be approved by the Engineer. These updated and approved shop drawings shall be sent to the Structural Materials Testing Section at least 24 hours in advance of the start of production.

(C) Plant and Personnel Certifications:

All precast bridge members shall be manufactured in a plant certified by the Precast/Prestress Concrete Institute (PCI). The manufacturer shall be, at a minimum, certified for Product Group "B"- Bridge Products, Category B4. Erection of precast/prestress bridge members shall be performed by a contractor, manufacturing plant, or erector which has an individual on staff who has attended and received a "Certification of Completion" from the PCI "Industry Erection Standards School" or is certified by PCI as a "Certified Field Auditor".

All precast concrete products, other than concrete pipe, shall be manufactured in a plant certified by the National Precast Concrete Association (NPCA) or PCI.

All precast concrete pipe products and precast concrete box culverts shall be manufactured in a plant certified by the American Concrete Pipe Association (ACPA) or NPCA.

All plant certifications shall be maintained throughout the production of all precast concrete items. Production for projects shall stop immediately if at any time the manufacturer's certification is revoked, regardless of the status of completion of contracted work. Production shall not proceed until certification has been re-established.

Each plant requesting to be added to the "Approved Precast Concrete Products Manufacturers List" or the "Approved Precast/Prestressed Bridge Members Manufacturers List" shall do so in writing to the

Structural Materials Testing Section. The request shall include a copy of the compliance certificate issued by the ACPA, NPCA, or PCI, a copy of the most recent audit conducted in accordance with the ACPA, NPCA, or PCI certification programs, a copy of the response to deficiencies of the audit upon request, a copy of the Quality System Manual (QSM), and the designated Quality Control (QC) Manager for the plant.

The contractor shall provide documentation to the Structural Materials Testing Section for any changes to the manufacturer's QSM, certified personnel, or plant certifications within 10 days of the respective change.

The QSM shall contain, at a minimum, the methods of production and quality control policies and procedures used by the plant. The QSM shall be in accordance with ACPA, NPCA, or PCI Plant Certification requirements and their respective programs.

Each manufacturer on the "Approved Precast Concrete Products Manufacturers List" or the "Approved Precast/Prestressed Bridge Members Manufacturers List" is required to submit to the Structural Materials Testing Section, a copy of the annual audit and the response to deficiencies of the audit, if applicable, to verify compliance with the ACPA, NPCA, or PCI certification programs.

If an audit is not completed or audit documents are not submitted within a period of 16 months of the last audit date, the plant will be removed from the approved list for a minimum of two months. After the two months, the manufacturer can apply to have the plant reinstated to the approved list. Reinstatement is subject to review and compliance with the Structural Materials Testing Section.

In the event of a change in ownership of an approved manufacturer, the manufacturer shall notify Structural Materials Testing Section of the change in ownership a minimum of 30 days prior to the date at which the change of ownership takes effect. Approval will expire if the Department is not notified of the change in ownership. The new ownership may avoid expiration by submitting a statement to the Structural Materials Testing Section indicating recognition of the details of the approval requirements, any changes to personnel and certifications, and verification that the plant is in accordance with the ACPA, NPCA or PCI certification program requirements.

The Engineer may conduct annual audits on a random basis of each approved precast manufacturer.

For precast concrete products, the manufacturer shall have either a Registered Professional Engineer or a QC Manager who has at least one of the following certifications:

(1) PCI QC Level II;

(2) NPCA Production & Quality School (PQS) Level II QA/QC and Production; or
(3) ACPA Q-school.

For precast bridge members, the manufacturer shall have a Registered Professional Engineer or QC Manager who is certified by PCI as QC Level II or higher. In addition, the QC Manager shall be certified, or have a technician(s) performing QC testing, as an ACI Concrete Field Testing Technician Grade I and ACI Concrete Strength Testing Technician Grade I.

In the event of a change in QC Manager or certified QC Technician, the manufacturer shall notify the Structural Materials Testing Section of the change within 30 days. Failure to notify the Department of the change will result in the expiration of the approval. Expiration may be avoided by notifying the Structural Materials Testing Section of any changes to personnel and include their certifications, and verification that the plant is in accordance with the ACPA, NPCA or PCI certification program requirements.

(D) Plant Quality Control:

The contractor shall submit the concrete mix design(s) along with shop drawings to the Structural Materials Testing Section for approval.

The shop drawings shall contain at the minimum:

(1) Concrete strength requirements;
(2) Method of concrete placement;
(3) Method of concrete vibration;
(4) Method of curing;
(5) Tensioning method and calculations, including stressing jacks and pumps, gauge pressure values and theoretical elongations;
(6) Detensioning method;
(7) Concrete finishing requirements and method of finishing; and
(8) Storage method.

When Requests for Information (RFI) are submitted to the Engineer, a copy of the RFI shall also be submitted to the Structural Materials Testing Section.

The manufacturer shall fabricate concrete test cylinders for each product, strength requirement, and mix design per each day of production. When “dry cast” or “zero slump” concrete is used, the concrete test cylinders will be fabricated per ASTM C497. For “wet cast” concrete, the concrete test cylinders will be fabricated per AASHTO T 23. When “Self Consolidating Concrete” (SCC) is used, the concrete test cylinders shall be fabricated, and unit weight and air content tests

shall be performed as described in Subsection 1006-4.05 (E) of the specifications.

Release strength shall be met prior to detensioning. At the discretion of the Engineer, release strength testing may be performed at the plant under the observation of the Engineer, if not performed by the Engineer.

Concrete test results shall be made available upon request.

(E) Precast Concrete Operations:

When requested, the precast manufacturer shall supply a monthly concrete compressive strength report, which contains the following information:

Daily average concrete compressive strength;

Monthly average concrete compressive strengths, with the high test result, the low test result, and the standard deviation of concrete compressive strength results;

Weekly aggregate gradation and sand equivalent test results; and

For SCC, results of “Column Segregation Test”, when requested by the Engineer.

(1) Precast Bridge Members Concrete Operations:

Concrete mix designs shall be submitted and comply with the requirements of Subsection 1006-3.01 of the specifications, and the requirements listed herein. Calibration reports for batch plants scales and measuring devices shall be supplied to the Engineer upon request.

All concrete used in the production of precast bridge members at the manufacturer’s plant or purchased from a Ready Mix supplier shall be batched with load cell indicating devices providing a digital readout and printed weights. Printed copies shall be available upon request by the Engineer.

The rate of concrete placement and consolidation shall be such that the formation of cold joints within monolithic sections of any bridge member shall not occur, but at no time shall concrete placement be less than 25 cubic yards per hour.

When consolidating concrete that includes epoxy coated reinforcement which requires vibration during placement, methods of vibration shall be equipped with neoprene or rubber boots or like material that protects the epoxy coatings from damage and/or abrasion.

When concrete placement is interrupted by rain, the forms shall be covered with tarps or plastic. If it is determined that concrete placement can proceed during rain, tarps or plastic shall be used to cover the forms ahead of and behind the concrete placement.

(2) Precast Concrete Products Concrete Operations:

Calibration reports for batch plant scales and measuring devices shall be supplied to the Structural Materials Testing Section when requested. Each precast plant shall submit a "Hot Weather" and/or a "Cold Weather" concrete batching and placement plan which addresses the steps that will be taken to ensure concrete temperature and curing meets the specifications. The plan shall specify procedures detailing how the concrete temperature will be monitored throughout each day's production. The Structural Materials Testing Section may test concrete temperature at any time. Concrete failing to meet the specification will be rejected along with any precast products produced that day.

The precast manufacturer shall supply annual test results for aggregate as required per ASTM C33, and also an annual absorption test on manufactured products.

All concrete batched at the manufacturer's plant, or purchased from a ready mix supplier, shall be batched with load cell indicating devices providing a digital readout and printed weights. Copies shall be available when requested by the Structural Materials Testing Section.

The rate of concrete placement and consolidation shall be such that the formation of cold joints within monolithic sections will not occur.

When consolidating concrete that includes epoxy coated reinforcement which requires vibration during placement, methods of vibration shall be equipped with neoprene or rubber boots or like material that protects the epoxy coatings from damage and/or abrasion.

When a stripping strength is specified, the manufacturer may determine the concrete strength using Arizona Test Method 318, "Estimating the Development of Concrete Strength by Maturity Method."

When concrete placement is interrupted by rain, the forms shall be covered with tarps or plastic. If it is determined that concrete placement can proceed during rain, tarps or plastic shall be used to cover the forms ahead of and behind the concrete placement.

(3) Self Consolidating Concrete (SCC):

SCC shall be flowable under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of any vibration, while maintaining homogeneity. Placement is to be accomplished in one lift, with the placement equipment within 25 feet of the rolling edge that the SCC creates.

Trial mixes shall be observed by an ADOT representative. Trial mixes may include an inverted slump spread test in accordance with ASTM C1611, L-box, J-box, J-ring, Column Segregation Test, or other tests as deemed necessary by the Engineer for the concrete mix approval. In addition, the following is required:

(a) The visual stability index (VSI), performed in accordance with ASTM C1611, shall be determined for each precast concrete product being produced;

(b) Any viscosity modifying agents (VMA) shall be identified for the mixture; and

(c) The spread shall be within ± 3 inches of the design spread defined in the mix design.

Concrete strength test cylinders shall be fabricated in accordance with ASTM C31, but filling the molds shall be done in accordance with ASTM C1758.

Concrete unit weight and air content tests shall be performed in accordance with ASTM C138 and ASTM C231, respectively, but filling the cylinder molds shall be done in accordance with ASTM C1758.

1006-5 Weather and Placement Limitations:

1006-5.01 General Requirements:

Concrete shall not be placed during adverse conditions, which may include but are not limited to rain, snow, freezing weather, unstable site conditions, excessively high ambient temperature, and high winds, unless approved by the Engineer.

Under rainy conditions, placing of concrete shall be stopped before the quantity of surface water is sufficient to cause a flow or wash of the concrete surface or have a detrimental effect on the finished concrete and acceptance parameters.

Placing of concrete shall immediately cease if the hauling vehicles or any equipment or pedestrian traffic tracks mud on the prepared base or changes the allowable subgrade dimensional tolerances for Class P concrete and slabs placed on subgrade for Class S or Class B concrete.

1006-5.02 Hot Weather Concreting:

Forms, subgrade, and reinforcing steel shall be lightly sprinkled with cool water just prior to the placement of concrete.

Chilled mix water or well crushed ice (substituted as a part of the mix water on a pound for pound basis) may be used to control the concrete temperature.

Aggregate may be cooled by systematic sprinkling of aggregate stockpiles for evaporative cooling or by the use of liquid nitrogen systems.

If required by the Engineer, windscreens shall be used to reduce the evaporation rate when curing methods alone are not sufficient to maintain the evaporation rate within acceptable limits. On bridge decks, windscreens shall project at least 6 feet above the prepared bridge deck surface. Windscreens may be made of any construction material that provides sufficient strength to resist the force of the wind.

If during finishing an unexpected environmental change or delay occurs, a monomolecular film product that aids in retarding the evaporation may be used prior to finishing with the Engineer's approval. The monomolecular film shall be applied in accordance with the manufacturer's recommendations. The evaporation retarder shall be applied in a fine mist using suitable sprayers; it shall not impact the plastic concrete surfaces in a stream.

Concrete surfaces to which an evaporative retardant has been applied shall not be subjected to finishing which mixes the retardant into the plastic concrete. Application of an evaporation retardant shall not delay the placement of curing compound as described in Subsection 1006-6.01(C) of the specifications.

1006-5.03 Cold Weather Concreting:

Concrete shall not be placed on or against ice-coated forms, reinforcing steel, structural steel, conduits, or construction joints; nor on or against snow, ice, or frozen earth materials. Immediately prior to placing concrete, the temperature of forms, reinforcing steel, earthen material, or any other material that will come in contact with the freshly placed concrete shall be a minimum temperature of 40 degrees F. If artificial heat is used to adjust the temperature of the items that will come in contact with the freshly mixed concrete, the temperature of these items shall not exceed 10 degrees F greater than that of the concrete being placed.

Concrete operations shall be discontinued when a descending ambient temperature in the shade and away from artificial heat falls below 40 degrees F. Concrete operations shall not be resumed until an ascending ambient temperature in the shade and away from artificial heat exceeds 35 degrees F unless otherwise approved by the Engineer.

Mixing and placing concrete shall continue no later than that time of day which allows sufficient time to place and protect the concrete already poured before the ambient temperature drops to 35 degrees F.

Concrete shall be protected in a manner to maintain all concrete surface temperatures at not less than 50 degrees F for a period of 72 hours after placement and at not less than 40 degrees F for an additional 96 hours.

The contractor may use equipment to heat the aggregates or water, or both, prior to mixing. If aggregates are heated, the minimum temperature of the heated aggregate shall be 60 degrees F and the aggregates shall have no chunks of ice or frozen aggregate present. Equipment used to heat the aggregates shall be such that consistent temperatures are obtained throughout the aggregate within each batch and from one batch to another. Water shall not be heated in excess of 150 degrees F unless the water is mixed with the aggregate prior to the addition of cement to the batch. During the heating or mixing process, cement shall not be added to water and aggregate combinations which exceed 100 degrees F.

When weather forecasts indicate a probability that ambient temperatures are to fall below 35 degrees F during the placement or curing periods, the contractor shall submit a cold weather concreting plan to the Engineer for approval prior to concrete placement. The cold weather concreting plan shall detail methods and equipment which are to be used to ensure that the required concrete temperatures are maintained. The contractor shall provide adequate cold weather protection in the form of insulation and/or heated enclosures to protect the concrete after placement. For bridge decks and suspended structures, the cold weather concreting plan shall include protection measures for both the top and bottom surfaces of the concrete. This protection shall maintain concrete surface temperatures as specified above at all locations in the structure. When artificial heating is required, the heating units shall not locally heat or dry the surface of the concrete.

When a cold weather concreting plan is required, the Engineer may require concrete temperatures to be measured and continuously recorded by the use of temperature sensing devices during the entire curing period. The contractor shall provide the temperature sensing devices, including its manufacturer's certification which shall be in accordance with ASTM C1074, and recording instruments. The contractor shall install temperature sensing devices near the surface of the concrete at locations and depths designated by the Engineer. When concrete is placed on a bridge deck or suspended structure, both the bottom surface and the top surface shall be monitored with temperature sensing devices. Temperature sensing devices and recording instruments shall be approved by the Engineer. The contractor shall continuously monitor the concrete temperature and provide the recorded data to the Engineer upon request.

If the surface concrete temperature at any location in the structure falls below 35 degrees F during the curing period, the Engineer may direct the contractor to core the areas in question at the locations indicated by the Engineer. The contractor shall submit the cores to a petrographer for examination in accordance with ASTM C856. Concrete damaged by frost, as determined by the petrographer, shall be removed and replaced

at no additional cost to the Department. All costs associated with coring, transmittal of cores, and petrographic examination shall be at no additional cost to the Department regardless of the outcome of the petrographic examination.

The placing of concrete will not be permitted until the Engineer is satisfied that all the necessary protection equipment and materials are on hand at the site and in satisfactory working condition.

Concrete requiring cold weather protection shall have such protection removed at the end of the required curing period in such a manner that will permit a gradual drop in the concrete temperatures.

1006-6 Curing Concrete:

1006-6.01 Curing Cast-in-Place Concrete:

(A) General Requirements:

All cast-in-place concrete shall be cured by one, or by a combination of more than one, of the methods specified herein and curing shall begin immediately after completion of machine or hand finishing of the fresh concrete.

Curing shall be continued for a period of at least seven days after placing if either Type II Portland cement or Portland pozzolan cement has been used, or for at least three days if Type III Portland cement has been used.

Surfaces requiring a Class II finish shall not be cured by the Liquid-Membrane Forming Compound Method until after the finishing operations are completed.

No traffic, hauling, storing of material or other work shall be allowed on any concrete surface during the required curing periods.

(B) Water Curing Method:

All surfaces not covered by reasonably waterproof forms shall be kept damp by applying water with a nozzle that so atomizes the flow of the water that a fog mist and not a spray is formed until the surface of the concrete is covered with a curing medium or sprinkling of the surface is permitted. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

If a curing medium is used, the concrete shall be kept continuously wet by sprinkling with water for the entire curing period. Burlap, rugs, carpets, or earth or sand blankets may be used as a curing medium to

retain the moisture during the curing period. Application of the curing medium shall not begin until such time that placement can be made without marring the surfaces of the concrete. Application of a non-atomized spray of water, water by brushes, or any other non-approved method will not be permitted.

Fogging equipment shall consist of a mechanically operated pressurized system using incrementally spaced triple headed nozzles or equivalents. The nozzles shall be pointing horizontally, parallel to the surface of the concrete and at a distance not to exceed 36 inches above the concrete surface.

The fogging equipment shall be mounted such that it is stationary. Each nozzle shall be equipped with an easily accessible control capable of varying the volume of water flow and immediately shutting off the water when in the off position. Hand-held fogging equipment will not be allowed.

If a curing medium is not used, the entire surface of the concrete shall be kept damp by the application of water with an atomizing nozzle as specified above until the concrete has set, after which the entire surface of the concrete shall be sprinkled continuously with water for the entire curing period.

In no case shall curing be interrupted by more than one hour during the curing period.

(C) Liquid-Membrane Forming Compound Method:

Liquid membrane forming compound shall conform to the requirements of ASTM C309 and also meet the criteria in Table 1006-8. Approval of curing compound will be based on a Certificate of Analysis conforming to the requirements of Subsection 106.05 of the specifications submitted for each lot. Curing compound shall not be used on a project prior to approval.

Any curing compounds not previously approved for use on a current or past ADOT project shall be tested for pre-approval by the Structural Materials Testing Section prior to the submittal of the Certificate of Analysis. The pre-approval testing shall be determined by the Engineer and in accordance with the requirements in Table 1006-8.

The approval of Type 2 (white pigmented) curing compounds shall be effective for a maximum of six months from the production date. The approval of Type 1-D (clear or translucent with fugitive dye) curing compounds shall be effective for a maximum of 12 months from the production date.

TABLE 1006-8 Testing Criteria for Liquid Membrane Forming Compound		
Procedure	**Criteria**	
Color	Clear (Type 1-D)	White (Type 2)
Deleterious Reaction w/ Concrete	No Reaction	No Reaction
Drying Time Test	Less than 4 hours	Less than 4 hours
Moisture Loss (72 hours)	Less than 0.55 kg/m²	Less than 0.55 kg/m²
Reflectance Test	N/A	60% or greater
Three-Day Settlement Test (MNDOT Procedure)	Less than 2 ml after 3 days	Less than 2 ml after 3 days
Non-volatile Content Test (D2369 Method A)	Minimum 25%	Minimum 25%

The Engineer shall reserve the right to sample curing compound at the source to perform tests specified in ASTM C309 for verification purposes. Sampling frequency will be at the discretion of the Engineer. Curing compound with failing verification test results shall not be used.

All surfaces not covered by waterproof forms shall be cured by the liquid-membrane forming compound method. The curing compound shall be applied to the concrete immediately following the surface finishing operation in one or more applications totaling a rate of at least 1 gallon per 100 square feet. The contractor shall not exceed the coverage rate specified in ASTM C309.

The curing compound shall form a continuous unbroken surface.

Type 2 compound with either a Class A or Class B vehicle shall be used for concrete pavement, bridge decks, and approach slabs. Type 1-D compound with either a Class A or Class B vehicle shall be used for other concrete items.

If the membrane film is broken during the curing period, the broken area shall be given a new application of compound at a rate sufficient to ensure uniform coverage.

In no case shall curing be interrupted by more than one hour during the curing period.

(D) Forms in Place Method:

Formed surfaces of concrete may be cured by retaining the forms in place. The forms shall remain in place for the entire curing period.

All joints in the forms and the joints between the end of forms and concrete shall be kept moisture-tight during the curing period.

Cracks in the forms and cracks between the forms and the concrete shall be resealed by methods approved by the Engineer.

(E) Curing Bridge Decks, Approach Slabs, and Anchor Slabs:

The top surface of bridge decks, approach slabs, and anchor slabs shall be cured by the liquid-membrane forming compound method and by the water curing method. The curing compound shall be applied progressively immediately following the surface finishing operation.

Water curing shall be applied not later than four hours after the completion of the surface finishing operations and shall be applied as specified herein.

The top surface of bridge decks, approach slabs, and anchor slabs that will be covered with a special riding surface or waterproofing membrane shall be cured by the water curing method only. Water curing shall be applied progressively immediately following the surface finishing operation as specified herein.

1006-6.02 Curing Precast Concrete:

(A) General Requirements:

The contractor may cure precast concrete in accordance with the requirements specified above for curing cast-in-place concrete or the curing of precast concrete may be performed by external heating. This may be accomplished by the use of low-pressure steam or radiant heat with moisture.

If curing of the concrete is accomplished by low-pressure steam or radiant heat with moisture, curing will be considered completed after termination of steam or radiant heat curing. Rapid temperature changes in the concrete shall be avoided during the cooling period.

If curing of the concrete is accomplished by the water curing method, the liquid-membrane forming compound method, or the forms-in-place method, such curing shall be continued for a period of at least seven days after placement of the concrete. The curing time may be reduced to a minimum of three days when a Type III Portland cement has been used.

For precast items, when a concrete mix contains silica fume, a curing plan acceptable to the Engineer shall be submitted for approval.

Concrete test cylinders shall be initially cured with, and in the same manner as the precast concrete products. Final curing will be per AASHTO T 23/ASTM C31.

(B) Low-Pressure Steam Curing:

After placement of the concrete, precast items shall be held for a minimum two-hour presteaming period. If the ambient air temperature is below 50 degrees F, steam shall be applied during the presteaming period to hold the air surrounding the precast item at a temperature between 50 and 90 degrees F. When the ambient temperature falls below 50 degrees F, steam or radiant heat may be used to keep the enclosure at a temperature of not more than 90 degrees F until the accelerated curing period begins.

Accelerated curing shall not commence until one hour after initial set or three hours after placement of concrete, whichever is longer. Initial set will be determined in accordance with ASTM C403 and the results submitted with each mix design.

To prevent moisture loss on exposed surfaces during the presteaming period, precast items shall be covered as soon as possible after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.

Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner to prevent the loss of steam and moisture.

Steam at the jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders or forms. During application of the steam, the ambient air temperature rise within the enclosure shall not exceed 40 degrees F per hour. The average curing temperature throughout the enclosure shall not exceed 160 degrees F and shall be maintained at a constant level for a sufficient length of time so as to ensure the development of the required compressive strength by the age of 28 days in concrete items which are not be prestressed. The concrete temperature during accelerated curing shall not exceed 170 degrees F. The manufacturer shall have a temperature measuring device(s) that allows the Department to monitor the concrete curing temperature at all times. For items which are to be prestressed, the constant temperature shall be maintained for sufficient time necessary to develop the concrete compressive strength required for prestressing. The ambient curing temperature shall not exceed 175 degrees F at any point. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.

Temperature recording devices that will provide an accurate continuous permanent record of the ambient curing temperature shall be provided. A minimum of two temperature recording devices or one for every 200 feet of continuous bed length are required for checking temperature. The location of each temperature measuring device will be chosen by the Engineer. The enclosure around each precast concrete item shall be

adequate to ensure a consistent concrete curing temperature. Once the curing enclosure procedure is established, the concrete curing temperature shall be monitored at one location for each precast item. A temperature measuring device shall be placed in each precast bridge member. The difference in the concrete curing temperature at the ends of each precast bridge member shall not exceed 20 degrees F. Forms shall not be considered a component of the enclosure during accelerated curing. A temperature measuring device shall be placed in at least two precast concrete products. The difference in the concrete curing temperature at any location within the enclosure for a precast concrete product shall not exceed 20 degrees F. When box girders or voided slab lengths are less than 60 feet, the concrete curing temperature shall be measured on every other bridge member. The manufacturer shall supply a report of the concrete curing temperatures for each concrete casting.

In the event the side forms are removed before the precast unit has attained the required release compressive strength, the curing method shall be continuous in maintaining the temperature and moisture level as described above, within the enclosure, as nearly as practical. There shall not be a delay in re-covering the girder or prestress member.

(C) Radiant Heat With Moisture:

Radiant heat shall be applied by means of pipes circulating steam, hot oil or hot water, or by heating elements or electric blankets on the forms. Pipes, blankets or elements shall not be in contact with the concrete surfaces.

Moisture shall be applied in such a manner as to keep the top surface of the precast unit continuously moist during the curing period by fogging or spraying. Moisture shall be maintained by a cover of burlap or cotton matting and further covered by a waterproof tarpaulin with an insulating cover.

Temperature limits and the use of recording thermometers shall be the same as curing with low-pressure steam. Application of the heat cycle may be accelerated to meet climatic conditions upon the approval of the Engineer. A temperature sensing device shall be placed 2 ± 1/2 inches from the heated form.

1006-7 Acceptance Sampling and Testing:

1006-7.01 General:

Sampling and testing of concrete will occur to determine the acceptability of the concrete in accordance with the test methods and criteria identified below. Concrete satisfying the criteria shown in the following sections is acceptable for use in the work. Rejection of concrete delivered to the site may occur due to failure to satisfy or achieve the specified criteria including, but not limited to: improper temperature, slump, air content, or batch quantities that excessively

deviate from the mix design. The Engineer may allow deficient concrete mixtures already placed to remain in place subject to final acceptance by the 28 day compressive strength testing provided there is confirmation that the placement had adequate consolidation throughout the pour. Deficient concrete mixtures due to insufficient air content, or improper slump which exhibit the appearance of segregation or lack of adequate consolidation, will not be accepted and shall be removed at no additional cost to the Department.

For the mixture delivered to the site, the weights and volumes shall be within the tolerances described in Subsection 1006-4.02 of the specifications for each component.

Acceptance and penalties for placed concrete which meets the specified mixture requirements or is allowed to remain in place shall be determined by the results of the 28-day compressive strength as specified in Subsection 1006-7.03 of the specifications, and additionally in the case of Class P concrete, on the measured thickness of concrete pavement in place as specified in Section 401 of the specifications. Sampling and testing for compressive strength will be performed on all classes of concrete furnished, including each strength specified on the project plans for Class S concrete.

1006-7.02 Field Sampling and Testing:

(A) General:

A sample of concrete for determination of temperature, slump, unit weight (when required), and air content (when required) as well as for fabrication of test cylinders for compressive strength determination at 28 days will be taken at random at the specified sampling frequency for each type of concrete.

When “Self Consolidating Concrete” (SCC) is used, the concrete test cylinders shall be fabricated, and unit weight and air content tests shall be performed as described in Subsection 1006-4.05(E) of the specifications.

All sampling and testing shall be done by a certified technician meeting the requirements of the ACI Concrete Field Testing Technician, Grade I or equivalent.

Required testing of concrete will be performed in accordance with the methods shown in Table 1006-9.

TABLE 1006-9 Sampling and Testing Test Procedures	
Temperature	ASTM C1064
Slump	ASTM C143
Air Content	ASTM C231 or C173
Sampling	ASTM C172
Making and Curing Cylinders	ASTM C31
Compressive Strength	ASTM C39
Unit Weight and Yield	ASTM C138

Concrete shall be sampled in accordance with ASTM C172 for acceptance testing of temperature, slump, unit weight and yield (when required) and air content (when required) as well as for fabrication of test cylinders for compressive strength determination at 28 days except that the concrete shall be sampled once during discharge at the middle portion of the batch. ASTM C172 includes sampling from stationary, paving and truck mixers, and from agitating and non-agitating equipment used to transport central-mixed concrete and from continuous mixing equipment as described in Specification ASTM C685/C685M. Sampling shall be at the point of discharge from truck mixers. Sufficient care shall be taken to obtain a representative sample by diverting the entire stream of the concrete to prevent segregation. Samples shall be of sufficient size to perform all the required tests and fabricate the necessary test cylinders but in no case less than 1 cubic foot.

If the properties of the concrete do not appear to be within the specification mix design limits for slump, or air content, a preliminary sample may be obtained after discharge of 1/4 cubic yards for initial check testing. If the preliminary measurement falls outside the specified limits, concrete placement shall be discontinued and addressed as follows:

(1) When the measured slump or air content, or both is greater than the specified mix design upper limit, another check test shall be made immediately on a new test sample. In the event the second check test fails, the concrete shall be considered to have failed the requirements of 1006-7.03(A) and shall be rejected;

(2) When the measured slump is below the mix design specified lower limit, additional water may be added in accordance with the requirements of 1006-7.03(A). In place of the addition of water to adjust the slump, an approved water reducing admixture may be added to increase workability. After any additions, the drum shall be turned at least 30 revolutions at mixing speed and a check test shall be made on a new sample of the adjusted concrete to verify compliance with 1006-7.03(A); and

(3) When the measured air content falls below the mix design specified limit, an approved air entrainment admixture may be added to increase the air content by an

authorized representative of the ready mix supplier that has been approved by the Engineer. After any additions, the drum shall be turned at least 30 revolutions at mixing speed and a check test shall be made on a new sample of the adjusted concrete to verify compliance with the mix 1006-7.03(A).

Preliminary samples for check testing do not take the place of acceptance samples. Once any additions, adjustments, and associated mixing are complete, another sample from the middle portion of the batch shall be taken for acceptance testing.

All compressive strength test specimens shall be made, cured, handled, protected, and transported in accordance with the requirements of ASTM C31. A safe storage location(s)/facilities shall be secured for the use of the testing laboratory(ies)/technician(s) to ensure proper curing of concrete test cylinders on the project site, including sufficient access on weekends and holidays to allow the timely pick-up of cylinders specimens. Upon arrival at the testing laboratory, all compressive test specimens shall be handled, cured, and tested in accordance with the requirements of ASTM C39. Any and all deviations from the standard procedure of any test method shall be promptly identified and corrected. Any deviations shall be clearly noted by the testing technician on reports. Should an individual cylinder show evidence of improper sampling, molding, curing, or testing, the results shall be discarded and the compressive strength shall be the result of the average of the remaining cylinder(s).Testing results obtained from non-standard testing procedures shall be considered invalid and discarded by the Engineer.

If approved by the Engineer, and unless otherwise specified, Arizona Test Method 318 may be used to estimate concrete strength by the maturity method. The maturity method shall not substitute for compressive strength acceptance testing (28-day cylinders). The contractor shall submit a written request to the Engineer prior to using the maturity method. If its use is approved by the Engineer, the contractor shall develop a strength-maturity relationship and shall also provide the maturity meter(s) and digital data loggers necessary, as well as performing all required testing, all at no additional cost to the Department.

(B) Class S and Class B Concrete:

For Class S concrete with a compressive strength requirement less than 4000 psi, or Class B concrete, a strength test will consist of the average strength of two test cylinders. However, if the compressive strengths of the two test cylinders differ by more than 10 percent from the average of the two, the strength test result shall be the cylinder with the highest compressive strength.

For Class S concrete with a compressive strength requirement equal to or greater than 4000 psi, or Class P concrete, the compressive strength of each sample shall be determined by averaging the results of the three

test cylinders. However, if the compressive strength of any one of the three test cylinders differs by more than 10 percent from the average of the three, its result shall be discarded and the compressive strength shall be the average of the remaining two cylinders. Should the individual compressive strength of any two of the three remaining cylinders differ by more than 10 percent from the average of the three, the results will be discarded and the compressive strength shall be the strength of the remaining cylinder.

(C) Class P Concrete:

Samples of concrete shall be taken in accordance with the requirements of ASTM C172, except concrete for Class P shall be sampled immediately before going into the paver or forms, or as otherwise directed by the Engineer.

(D) Precast Concrete

(1) Major Precast Concrete Structures

The concrete will be field sampled and compressive strength tested by the Engineer in accordance with the requirements in 1006-7.02 for Class S with the addition of the following:

Fabrication of test cylinders for compressive strength determination shall be done for one day (for release breaks), seven days, and 28 days. The acceptance samples shall represent one member, one day's production, or as determined by the Engineer.

(2) Minor Precast Concrete Structures

A strength test on each precast unit produced will consist of the average rebound number as determined from readings taken on the precast unit with a rebound hammer. The average rebound number will be determined in accordance with the requirements of ASTM C805.

The compressive strength of the concrete will be determined from the average rebound number and the calibration chart established for the specific rebound hammer being used. The calibration chart will be established from rebound readings taken on concrete test cylinders fabricated at the precast plant and the actual compressive strength of the cylinders.

1006-7.03 Acceptance Criteria:

Concrete acceptance test results and verifications shall be evaluated for acceptance using the criteria established in this section.

(A) Plastic Concrete

Plastic concrete is concrete which has been delivered to the project, is still in a workable state, and has not yet achieved initial set. The criteria used for accepting plastic concrete are as follows:

(1) Elapsed Time

The batch time is defined as the time at which cementitious material is combined with water or aggregate. Discharge from the truck mixer or truck agitator shall be completed within 90 minutes from batching. The Engineer may allow concrete placement to continue in excess of the 90 minutes if the concrete is of such slump, workability, and/or temperature that it can be placed without the addition of water to the batch. Additional discharge time shall also be allowed provided a hydration stabilizing admixture is shown on the approved mix design and has been included in the batch, subject to the following:

(a) The concrete remains of sufficient slump and workability to facilitate adequate consolidation during placement, and;

(b) The hydration stabilizing admixture conforms to the requirements of subsection 1006-2.04 of the specifications and retards hydration by a hydration stabilizing mechanism, and;

(c) The dosage rate is identified in the approved mix design, and the additional amount of batch to discharge time exceeding the 90 minute limit has been requested by the contractor for approval by the Engineer and acknowledged on the mix design by the Engineer, or;

(d) If during placement, the dosage range is identified in the approved mix design and the application-specific dosage and additional time has been requested by the contractor and approved by the Engineer.

(2) Temperature:

The temperature of the concrete mixture immediately before placement shall not be less than 50 degrees F nor greater than 90 degrees F. The Engineer may allow concrete placement to continue in excess of the maximum temperature if the concrete is of such slump or workability that it can be placed without the addition of water to the batch. The Engineer may also approve concrete mixtures with a temperature less than 50 degrees F or greater than 90 degrees F if otherwise specified or pre-approved by a mix design that accounts for the temperature deviation. Otherwise, concrete that fails to conform to this temperature requirement will be rejected prior to placement.

(3) Consistency:

The contractor shall furnish Class P Concrete having a slump within the range specified in Table 1006-5.

The contractor shall furnish Class S and Class B concrete having the slump shown on the approved mix design, with a permissible variation of ± 1 inch when the slump shown on the approved mix design is 4 inches or less, and a permissible variation of ±1½ inches when the slump shown on the approved mix design is greater than 4 inches. However, when an approved high range water reducing chemical admixture (ASTM C494, Type F or Type G) conforming to the requirements of Subsection 1006-2.04 of the specifications is used, the permissible variation will be ± 2 inches, unless otherwise required by the Special Provisions. Concrete that fails to conform to the consistency requirements will be rejected.

When concrete is pumped, samples for consistency will be taken as the concrete leaves the mixer.

If the workability of the concrete needs to be adjusted (or if additional mixing water is required to maintain the mix design water-cementitious material ratio), additional mixing water may be added as long as it does not exceed the amount of permissible water to meet the approved mix design maximum water tolerance, as noted on the delivery ticket. The concrete shall be mixed by a minimum of 30 revolutions of the drum at mixing speed after the water has been added, prior to discharge of any concrete for placement. The contractor shall ensure that any additional mixing water and required mixing revolutions shall be recorded on the delivery ticket as specified in Subsection 1006-4.03(D) of the specifications. This additional mixing may be in excess of the maximum revolutions at mixing speed previously specified.

(4) Air Content:

Where air-entrainment is utilized as identified in Section 1006-3.01(E) of the specifications, the air content of the concrete mixture at the point of placement shall meet the requirements in the following table:

TABLE 1006-10
Air Entrainment Requirements

Elevation	Air Entrainment Required	Required Air Content by Volume (%)
3000 feet or above	Yes	4 to 7
Below 3000 feet	Contractor's Option	≤7

Concrete that falls below the minimum may be adjusted with the addition of an approved air entrainment admixture in accordance with 1006-7.02(A). Concrete that fails to conform to the maximum air content requirements listed above for the respective elevation as determined by the Engineer, shall be rejected prior to placement.

(B) Hardened Concrete:

(1) Class P Concrete:

Class P concrete will be accepted for compressive strength in accordance with the provisions of Section 401 of the specifications. All concrete failing to meet the compressive strength requirement or otherwise rejected in accordance with Section 401 or Subsection 1006-7.01 of the specifications, shall be replaced with concrete meeting the requirements of these specifications.

If the contractor chooses to contest the compressive strength results of any sample for purposes of acceptability or improving a negative pay factor, the contractor may elect to rely on the results of compressive strengths of cores. Three cores shall be obtained at no additional cost to the Department, at the approximate location where the contested test cylinders were obtained. Such cores shall be obtained and tested in accordance with the requirements of ASTM C42. Cores must be obtained under the observation of an ADOT representative and delivered to the Engineer in time to allow complete testing within 48 days of placement. Testing shall be performed by the Department. The contractor may elect to have a representative present during testing. Compressive strength shall be the average of the results of the three cores. However, if the compressive strength of any one of the three cores differs by more than 10 percent from the average of the three, its result shall be discarded and the compressive strength shall be the average of the remaining two cores. Should the individual compressive strength of any two of the three cores differ by more than 10 percent from the average of the three, the results of both shall be discarded and the compressive strength shall be the result of the remaining core. Results of the core testing will be binding on both the contractor and the Department, and will replace the results of the test cylinders for that sample.

(2) Class S and Class B Concrete:

Class S and Class B concrete will be accepted for compressive strength and paid for in accordance with the following table. Concrete will be paid for by the linear foot or by the cubic yard, complete in place, except that an adjustment in the contract unit price, to the nearest cent, will be made for the quantity of concrete represented by 28-day compressive strength test results less than the specified requirement.

Adjustment in Contract Unit Price for Compressive Strength of Class S and Class B Concrete					
3000 psi and Below		**3500 psi**		**4000 psi and Above**	
Percent of Specified 28-Day Compressive Strength Attained, to the Nearest 1 Percent	Percent Reduction in Contract Unit Price (See Note 1)	Percent of Specified 28-Day Compressive Strength Attained, to the Nearest 1 Percent	Percent Reduction in Contract Unit Price (See Note 1)	Percent of Specified 28-Day Compressive Strength Attained, to the Nearest 1 Percent	Percent Reduction in Contract Unit Price (See Note 1)
100 or More	0	100 or More	0	100 or More	0
97 – 99	3	98 – 99	2	99	1
94 – 96	6	96 – 97	4	98	2
91 – 93	9	94 – 95	6	97	3
88 – 90	12	92 – 93	8	96	4
85 – 87	15	90 – 91	10	95	5
Less than 85	30 (See Note 2)	Less than 90	30 (See Note 2)	Less than 95	30 (See Note 2)

Notes:

(1) For items measured and paid for by the cubic yard, the reduction shall not exceed $150.00 per cubic yard.

(2) If allowed to remain in place.

Concrete failing to meet at least 85 percent of the 28-day compressive strength for specified strengths of 3,000 pounds per square inch and below, 90 percent for a specified strength of 3,500 pounds per square inch, or 95 percent for specified strengths of 4,000 pounds per square inch and above, or any concrete failing to meet the other requirements of Subsection 1006-7.01 of the specifications, will be rejected and removed at no additional cost to the Department and replaced with concrete which meets the specified requirements, unless the contractor can submit evidence that will indicate to the Engineer that the strength and quality of the concrete is such that the concrete should be considered acceptable and be allowed to remain in place.

If such evidence consists of cores, the contractor shall obtain three cores from the concrete represented by the failing cylinder strength test. The cores shall be obtained at no additional cost to the Department, under the observation of an ADOT representative, and delivered to the Engineer in time to allow complete testing of such cores within 48 days after the placement of the concrete. All cores shall be obtained and tested in accordance with the requirements of ASTM C42. Testing shall be performed by the Department. The contractor may elect to have a representative present during testing. The concrete represented by the cores will be considered for acceptance, in accordance with the requirements of the table above. If the average compressive strength does not meet the specified requirement, all concrete so represented shall be removed at no additional cost to the Department unless permitted to remain in place by the Engineer. Results of the core testing will be binding on both the contractor and the Department, and will replace the results of the test cylinders for that sample.

1006-7.04 Sampling Frequency for Cast-In-place Concrete:

(A) Class S and Class B Concrete:

For Class S concrete with a compressive strength requirement less than 4000 pounds per square inch, a sample of concrete for the required tests, as specified in Subsection 1006-7.02 of the specifications, will be taken on a daily basis for each 100 cubic yards, or fraction thereof, of continuously placed concrete from each batch plant. For Class S concrete with a compressive strength requirement equal to or greater than 4000 pounds per square inch, a sample of concrete for the required tests, as specified in Subsection 1006-7.02 of the specifications, will be taken on a daily basis for each 50 cubic yards, or fraction thereof, of continuously placed concrete from each batch plant. For Class B concrete, a sample of concrete for the required tests, as specified in Subsection 1006-7.02 of the specifications, will be taken for each 100 cubic yards placed from each batch plant. For Class S or Class B concrete placed at elevations of 3,000 feet or above, air content testing shall be performed for each 50 cubic yards placed, regardless of the compressive strength requirement. An additional sample or samples for any of the required tests may be taken at an interval of less than the sampling frequency specified above, at the discretion of the Engineer, on any batch or load of concrete. A sample for the required tests on daily placements of 10 cubic yards or less may be taken at the discretion of the Engineer.

(B) Class P Concrete:

Class P concrete shall be sampled and tested for compressive strength by the lot. A lot shall be considered to be one shift's production; however, a new lot shall begin when the mix design is changed. For partial shifts due to weather or other reasons, more than one day's production may be included in a lot. When such partial shifts occur, the contractor and the Engineer will jointly determine the lot limits. Five samples shall be obtained from each lot at random locations as directed by the Engineer. The Engineer may exclude certain locations from random sampling if the Engineer determines that the location of the work precludes normal construction operations. Three test cylinders shall be fabricated from each sample and tested for 28-day compressive strength in accordance with Subsection 1006-7.02 of the specifications.

Class P concrete shall be sampled and tested for temperature, slump, and air content (if applicable) a minimum of five times per lot. The frequency may be reduced for partial shifts with the approval of the Engineer. Additional samples for any of the required tests may be taken at the discretion of the Engineer.

(C) Precast Concrete:

A sample of concrete for the required tests as specified in Subsection 1006-7.02 of the specifications will be taken for either each

precast concrete member or for each day's production at the discretion of the Engineer.

An additional sample or samples for any of the required tests may be taken at the discretion of the Engineer. The Engineer will determine the quantity of concrete represented by each sample of concrete for any test performed.

When a sample of concrete for the required compressive strength test is taken to represent a single day's production and not each precast member, the degree of acceptance for all precast concrete members in that day's production will be established by the results of such compressive strength test.

SECTION 1007 RETROREFLECTIVE SHEETING:

1007-1 General Requirements:

Retroreflective sheeting shall consist of a retroreflective system having a smooth outer surface. The sheeting shall have a pre-coated adhesive on the back side protected by an easily removable liner, except for self-supporting products having a Class V backing, such as roll-up signs and some types of traffic cone collars. Sheeting shall conform to criteria listed in the most current version of ASTM D4956 for the applicable type and class, unless otherwise specified.

Only those retroreflective sheeting, inks, and film products that are currently shown in the Department's Approved Products List (APL) shall be used. Copies of the APL are available on the internet from the Arizona Transportation Research Center (ATRC), through its Product Evaluation Program.

A Certificate of Compliance, conforming to the requirements of Subsection 106.05 of the specifications, shall be submitted. The Certificate of Compliance shall identify the retroreflective sheeting type, backing class, make of sheeting, inks, and film intended for use in all manufactured devices, including signs, channeling devices, mileposts, object markers, guard rail markers, delineators and reference markers. The Engineer may accept all materials based on the certification or may require the contractor to furnish additional information or laboratory test results. Additionally, the Engineer may perform measurements on materials to determine their compliance with these specifications. Signs and other devices that have sheeting, inks or films that do not meet these requirements shall be rejected and shall be replaced at no additional cost to the Department.

1007-2 Material Types:

Sheeting for permanent warning signs, regulatory signs, and overhead-mounted guide signs, including all sign legends and borders, shall be ASTM Type XI.

Sheeting for all warning signs with yellow backgrounds shall be Type XI fluorescent retroreflective yellow.

Sheeting for information signs, ground-mounted guide signs, and marker signs, including all sign legends and borders, shall be ASTM Type IX or XI.

Sheeting for permanent object markers and delineators on a rigid substrate with yellow backgrounds, including guardrail end treatments, guardrail markers, rigid delineators, and impact attenuators, shall be Type XI fluorescent retroreflective yellow.

Sheeting for permanent object markers and delineators on a rigid substrate in colors other than yellow, including guardrail end treatments, guardrail markers, rigid delineators, and impact attenuators, shall be ASTM Type IX or XI.

Sheeting for object markers and delineators on a flexible or plastic substrate, including flexible delineators and sand barrels, shall be ASTM Type VIII, IX or XI.

For temporary regulatory and guide signs on a rigid substrate with fluorescent retroreflective orange sheeting, ASTM sheeting Types VIII, IX, or XI shall be used.

For temporary regulatory and guide signs on a rigid substrate in colors other than fluorescent retroreflective orange, ASTM sheeting Types IV, VIII, IX, or XI shall be used.

For retroreflective orange temporary signs on a flexible or roll-up substrate, ASTM Type VI sheeting shall be used.

All temporary signs (rigid, flexible, or roll-up) with orange backgrounds shall use fluorescent retroreflective orange sheeting, except that non-reflective sign materials may be used for temporary signs where the signs will be clearly visible under available natural light.

For barricades and other temporary channelizing devices, ASTM sheeting Types IV, VIII, IX, or XI shall be used.

Sheeting for Adopt-A-Highway signs shall be ASTM Type I, IV, or XI.

Logo signs shall be ASTM Type I, IX, or XI.

When more than one sheeting type is allowed, the contractor may use any of the types listed, provided that materials used for a particular

application shall be of the same ASTM type, manufacturer, and product for all signs of the same type in the project.

Opaque films used with sheeting shall be acrylic type films.

Direct-applied and demountable black characters shall be non-reflective.

1007-3 Visual Appearance, Luminance and Color Requirements:

Except as specified herein, the color of the sheeting, ink or film shall conform to the ADOT Manual of Approved Signs, the Manual on Uniform Traffic Control Devices (MUTCD), and the plans.

All sheeting, inks and film used shall be uniformly colored so there is no visual variation in their appearance on the same sign or from sign to sign of the same colors.

Standard colors specified for sheeting, processing inks, and films shall, as applicable, match visually and be within the color tolerance limits required by Highway Tolerance Charts issued by the Federal Highway Administration. Additionally, for the retroreflective sheeting, unless otherwise noted, the Luminance Factor (Daytime Luminance) and Color Specification Limits (Daytime) shall conform to the applicable requirements of ASTM D4956.

In addition to the luminance and color requirements, fluorescent orange sheeting and fluorescent yellow sheeting shall have the capacity to effectively fluoresce outdoors under low light conditions. For all applications requiring fluorescent orange sheeting or fluorescent yellow sheeting, the contractor shall provide a letter to the Engineer from the manufacturer certifying that the sheeting to be used is fluorescent.

1007-4 Coefficient of Retroreflection:

The coefficient of retroreflection shall meet the minimum requirements of ASTM D4956 for the type of retroreflective sheeting specified.

All black opaque films shall have a maximum coefficient of retroreflection of 1.0 or less at an observation angle of 0.2 degrees and entrance angle of -4.0 degrees.

1007-5 Color Processing:

Transparent and opaque inks used for post or pre-screen printing of signs shall be of a type and quality specified by the sheeting manufacturer, and shall conform to the applicable requirements of the MUTCD and the Federal Highway Administration for traffic signs. The inks shall be applied in a manner, and with equipment, that is consistent with the ink manufacturer's recommendations. Additionally, the signs

produced shall have a uniform legend of consistent stroke width and sharply defined edges, without blemishes that would negatively impact appearance, color or required retroreflectivity.

For sheeting applications using black ink, the maximum coefficient of retroreflection shall be 1.0 or less at an observation angle of 0.2 degrees and entrance angle of -4.0 degrees.

1007-6 Adhesive:

Reflective sheeting and film adhesives shall be Class I as specified in ASTM D4956 and as modified herein.

Pressure sensitive adhesive shall be an aggressive tack type that requires no heat, solvent or other pre-application preparation of the sheeting or film for its adhesion to clean aluminum, plywood, or reflective sheeting surfaces. Pretreatment of plastic surfaces shall be done as recommended by the sheeting manufacturer.

The adhesive shall form a tight weatherproof durable bond that shall endure under all weather conditions for the required time of durability for that material. During this period the material shall remain bonded to its surface without discoloration, cracking, crazing, peeling, blistering, dimensional change or alignment change.

1007-7 Weather Testing:

For the evaluation of sign sheeting products the Department has adopted a desert environment, 45 degree, south-facing outdoor acceleration test method. Sheeting will be tested for the time periods specified in Subsection 1007-8 of the specifications. The Department's test method will be considered to produce a two to one time-acceleration ratio for equivalent vertical exposure.

1007-8 Durability Requirements:

Sheeting stability will be determined using a durability rating which shall be equal to twice the testing periods listed below. Sheeting must be warranted by the manufacturer against the defects listed below for a period equal to the specified durability rating for each type of sheeting product. Only those sheeting products which provide the specified warranty will be acceptable.

Sheeting shall be weather-tested as specified above in Subsection 1007-7 of the specifications. Sheeting weather-testing periods and durability ratings shall be as specified in Table 1007-8. In all cases, the related inks and films shall be tested along with the respective sheeting, and shall be subject to the same durability requirements as the sheeting.

TABLE 1007-8			
ASTM Sheeting Type	**Color**	**Weather-testing period, months**	**Durability rating, years**
XI	Fluorescent yellow	42	7
XI	Fluorescent orange	18	3
XI	All other colors	60	10
IX	Fluorescent orange	18	3
IX	All other colors	60	10
VIII	Fluorescent orange	18	3
VIII	All other colors	30	5
VI	Fluorescent orange	18	3
IV	All colors	30	5
I	All colors	30	5

After weather testing for the periods specified above, sheeting and related inks and films shall show no significant degradation or reduced performance. Unacceptable degrees of degradation and reduced performance are as listed below:

(A) Bubbles, wrinkles, cracks or breaks on any portion of the applied materials greater than 3 inches in length that result in a negative appearance or concerns of additional degradation;

(B) Significant shrinkage that causes the material to curl or to pull away from the background;

(C) Significant delaminating of any material or layer (sheeting to substrate, sheeting to sheeting, sheeting to film, ink to sheeting, film to sheeting, or film to film);

(D) Significant visible discoloration, including clouding or chalking;

(E) A loss of transparency of any transparent sheeting, ink or film;

(F) A loss in opaqueness of any opaque ink or film;

(G) Significant cracking, blistering, ripping, flaking, curling or chipping of any sheeting, ink, or film; and

(H) A loss of nighttime retroreflectivity as observed at night under normal conditions, or as defined and measured with a portable retroreflectometer at an observation angle of 0.2 degrees and entrance angle of -4.0 degrees. The measured coefficient of retroreflection shall be consistent with what would be expected of the type of material being measured, normal manufacturing variations, the time that the material has been in the field, and FHWA requirements.

Those sheeting products which have been evaluated for the time periods specified above using the Department's own testing and evaluation program, and that have been shown to meet the durability requirements listed herein, are included on the Approved Products List.

Manufacturer's guarantees or warranties on all traffic sign material shall be transferred to the Department upon completion and acceptance of the project in accordance with the requirements of Subsection 106.13 of the specifications.

1007-9 Application:

The sheeting, inks, clear coats (if required), and films shall be applied as specified by the manufacturer. The applied sheeting or film shall not have bubbles, wrinkles or foreign materials beneath the reflective sheeting, ink or film.

SECTION 1008 PRISMATIC REFLECTORS:

1008-1 General Requirements:

The contractor shall furnish a Certificate of Compliance in accordance with the requirements of Subsection 106.05 of the specifications. The certificate shall state that the reflectors comply in all respects with the following requirements:

(A) The retroreflectors shall consist of a plastic face (herein referred to as the lens) and an opaque back fused to the lens (under heat and pressure) around the entire perimeter to form a homogeneous unit permanently sealed against dust, water, and water vapor. The retroreflector shall be clear (crystal) in color. The lens shall consist of a smooth front surface free from projections or indentations other than for identification and a rear surface bearing a prismatic configuration such that it will affect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

(B) The specific intensity of each acrylic retroreflector shall be equal to or exceed the minimum values in Table 1008-1 with measurements made with retroreflectors spinning.

1008-2 Delineator and Object Marker Retroreflectors:

The retroreflectors shall be either white, yellow, green, or red as specified and shall be ready for mounting.

The lens shall have a retroreflective area of not less than 6.5 square inches. Retroreflection shall be provided by the lens prismatic optical elements.

The following test shall be used to determine if a retroreflector is adequately sealed against dust, water or air.

Submerge 50 samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches gauge for five minutes. Restore atmospheric pressure and leave samples submerged for five minutes, then remove and examine the samples for water intake. Failure of three or more units shall be cause for rejection of the entire lot.

The delineator or object marker device shall consist of an acrylic plastic retroreflector unit mounted in a housing fabricated of 0.063-inch 3003-H-14 or similar aluminum, or of cold rolled, hot dip, galvanized steel, having a thickness of 0.064 inches. Housing dimensions, including assembly and post mounting hardware will be as shown on the plans or as specified in the contract. Attachment hardware shall permit easy removal with the proper tools, but that removal is not possible without the use of such tools.

The housing shall be protected against corrosion as recommended by the manufacturer.

1008-3 Cut-Out Letters, Symbols and Accessory Retroreflectors:

The retroreflectors shall be clear and transparent mounted as an integral part of the character. Five retroreflectors shall be submitted for test. Failure of one or more units shall constitute failure of the lot.

The sealed prismatic retroreflector units shall be tested for dust and water intrusion as follows:

(A) Submerge five retroreflectors in a water bath at room temperature. Subject the submerged units to a vacuum of 5 inches gauge (water) for five minutes, then examine them for water intake. Failure of one or more units shall constitute failure of the lot;

(B) Three reflectors shall be tested for four hours in a circulating air oven at 175 ± 5 degrees F. The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test, the retroreflectors shall be removed from the oven and permitted to cool in air to room temperature. The units, after exposure to heat and air cooling, shall show no significant change in shape and general appearance when compared with unexposed control standards. Failure of one or more units shall constitute failure of the lot; and

(C) The assembled cut-out letter, symbol, or accessory shall withstand the combined corrosion test set forth in ASTM B117. No failures permitted.

TABLE 1008-1
(Candelas per Footcandle per Square Inch)
Minimum Specific Intensity Per Unit Area (SIA):

Reflector Units						
Observation Angle: (Degrees)	**Entrance Angle: (Degrees)**	**Delineators & Object Markers**				**Cutout Letters, Symbols & Access.**
		***White**	**Yellow**	**Green**	**Red**	**Colorless**
0.1	0	17.7	6.5	4.6	4.6	14.0
0.1	20	6.9	3.8	1.8	1.8	5.6
0.33	0	-	-	-	-	10.0
0.33	20	-	-	-	-	4.0
0.17	0	-	-	-	-	7.0
0.17	20	-	-	-	-	2.8

Note:

* Crystal, Clear, or Colorless

SECTION 1009 ASPHALT-RUBBER MATERIAL:

1009-1 Description:

The work under this section shall consist of furnishing, proportioning and mixing all the ingredients necessary to produce an asphalt-rubber material. Asphalt-rubber material is also referred to as crumb rubber asphalt (CRA).

1009-2 Materials:

1009-2.01 Asphalt-Rubber:

(A) Asphalt Cement:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005 of the specifications.

(B) Crumb Rubber:

Crumb rubber shall be ambient ground and shall meet the following gradation requirements when tested in accordance with Arizona Test Method 714.

TABLE 1009-1	
Sieve Size	**Percent Passing**
No. 10	100
No. 16	75 – 95
No. 30	30 – 60
No. 50	5 – 30
No. 200	0 – 5

The crumb rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of wire or other contaminating materials and shall contain not more than 0.5 percent fabric. Calcium carbonate, up to 4 percent by weight of the crumb rubber, may be added to prevent the particles from sticking together.

Certificates of Compliance conforming to Subsection 106.05 of the specifications shall be submitted. In addition, the certificates shall confirm that the rubber is a crumb rubber, derived from processing whole scrap tires or shredded tire materials; and the tires from which the crumb rubber is produced are taken from automobiles, trucks, or other equipment owned and operated in the United States. The certificates shall also verify that the processing does not produce, as a waste product, casings or other round tire material that can hold water when stored or disposed of above ground.

1009-2.02 Asphalt-Rubber Proportions:

The asphalt-rubber shall contain a minimum of 20 percent crumb rubber by the weight of the asphalt cement when utilized in Asphaltic Concrete Friction Course (Asphalt-Rubber) mix. Other applications of asphalt-rubber shall contain a minimum of 18 percent crumb rubber by weight of the asphalt cement.

1009-2.03 Asphalt-Rubber Properties:

Asphalt-rubber shall conform to the following:

TABLE 1009-2			
Property	**Requirement**		
	CRA Type 1	**CRA Type 2**	**CRA Type 3**
Grade of base asphalt cement (shall conform to Table 1005-1)	PG 64-16	PG 58-22	PG 52-28
Rotational Viscosity: 177°C (350 °F); (ASTM D7741); Pascal·seconds	1.5 - 4.0	1.5 - 4.0	1.5 - 4.0
Penetration: 4°C (39.2 °F), 200 g, 60 sec. (ASTM D5);0.1 mm, minimum	10	15	25
Softening Point: (AASHTO T 53); °C, minimum	57	54	52

Resilience: 25°C (77°F) (ASTM D5329); %, minimum	30	25	20

If, during production, it is determined by testing that asphalt-rubber fails to meet the above requirements for the specified type, the material in which the asphalt-rubber is incorporated and represented by the corresponding test results shall be evaluated for acceptance. Should the material in which the asphalt-rubber is incorporated be allowed to remain in place, the contract unit price for asphalt-rubber will be adjusted by the percentage shown in Table 1009-3. Should the asphalt-rubber be in reject status, the contractor may, within 15 days of receiving notice of the reject status of the asphalt-rubber, supply an engineering analysis of the expected performance of the material in which the asphalt-rubber is incorporated. The engineering analysis shall detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is rejected, the material in which the asphalt-rubber is incorporated shall be removed and replaced with material meeting the requirements of the applicable specifications at no additional cost to the Department. If the contractor's proposal is accepted, the material in which the asphalt-rubber is incorporated shall remain in place at the applicable percent of contract unit price allowed, and any necessary corrective action shall be performed at no additional cost to the Department.

TABLE 1009-3
ASPHALT-RUBBER PAY ADUSTMENT TABLE

Test Property	CRA Type 1		CRA Type 2		CRA Type 3	
	Test Value	Percent of Contract Unit Price	Test Value	Percent of Contract Unit Price	Test Value	Percent of Contract Unit Price
Penetration	≥ 10 8-9 < 8	100 85 70*	≥ 15 13-14 < 13	100 85 70*	≥ 25 23-24 < 23	100 85 70*
Softening Point	≥ 57 55-56 < 55	100 85 70*	≥ 54 52-53 < 52	100 85 70*	≥ 52 50-51 < 50	100 85 70*
Resilience	≥ 30 24-29 18-23 < 18	100 85 70 50*	≥ 25 20-24 15-19 < 15	100 85 70 50*	≥ 20 15-19 10-14 < 10	100 85 70 50*

Notes:

(1) *Reject Status: The pay adjustment applies if allowed to remain in place.

(2) The virgin binder will be tested in accordance with Table 1005-1. Pay adjustments for the virgin binder will be applied in accordance with Table 1005-1. Should the asphalt-rubber or the virgin binder be deficient on more than one property from this table or Table 1005-1, the pay adjustment will be the greatest reduction to the contract price specified considering individual test results. The penalty will be applied to the total amount of asphalt-rubber.

1009-2.04 Asphalt-Rubber Design:

At least two weeks prior to the use of asphalt-rubber, the contractor shall submit an asphalt-rubber design prepared by an approved laboratory. The design shall be formulated using asphalt cement and crumb rubber that are representative of the materials to be utilized in production, and shall meet the requirements specified herein. The design shall show the values obtained from the required tests, along with the following information: percent, grade and source of the asphalt cement used; and percent, gradation and source(s) of crumb rubber used. In addition, the asphalt-rubber design shall include verification of the PG binder grade of the base asphalt; however, in lieu of the design including this information, a Certificate of Analysis conforming to Subsection 106.05 of the specifications from an accredited laboratory or the supplier of the PG base asphalt will be acceptable.

If changes are made in the type or source of asphalt cement or in the type or source of crumb rubber, a new asphalt-rubber design will be required.

The contractor may propose the use of an asphalt-rubber design that has been developed for a previous project. The proposed design shall meet the requirements of the specifications. The contractor shall provide evidence that the type and source of asphalt cement and the type and source of crumb rubber have not changed since the formulation of the previous design. The Engineer will determine if the previously used design is suitable for the intended use and if the previous use of the asphalt-rubber design was satisfactory to the Department. The Engineer will either approve or disapprove the proposed design. Should the Engineer disapprove the use of the previously used design, the contractor shall prepare and submit a new asphalt-rubber design proposal in accordance with the requirements of the specifications.

A previously used asphalt-rubber design more than one year old shall not be allowed for use. Once approved for use on a project, an asphalt-rubber design may be used for the duration of the project.

1009-3 Construction Requirements:

During production of asphalt-rubber, the contractor shall combine materials in conformance with the asphalt-rubber design unless otherwise approved by the Engineer.

1009-3.01 Mixing of Asphalt-Rubber:

The temperature of the asphalt cement shall be between 375 and 425 degrees F at the time of addition of the crumb rubber. No agglomerations of crumb rubber particles in excess of 2 inches shall be allowed in the mixing chamber. The contractor shall document that the amount of crumb rubber used does not deviate more than plus or minus 1.0 percent from the percentage specified in the accepted asphalt-rubber mix design. The temperature of the asphalt-rubber immediately after the initial dispersion of the crumb rubber into the asphalt cement shall be between 350 and 400 degrees F. The contractor shall ensure that the crumb rubber and asphalt cement for a particular batch have been thoroughly mixed and placed in the reaction tank prior to the beginning of the reaction period. The reaction period shall be a minimum of sixty minutes, during which time the asphalt-rubber is continuously agitated while a temperature between 350 and 400 degrees F is maintained. At any time, if the temperature falls below 350 degrees F, the reaction period shall begin anew when the temperature reaches 350 degrees F. The reaction period shall be completed before the asphalt-rubber is used. The contractor shall demonstrate that the crumb rubber particles have been uniformly incorporated into the mixture and that they have been “wetted”. The occurrence of crumb rubber floating on the surface or agglomerations of crumb rubber particles shall be evidence of insufficient mixing.

The contractor shall test the viscosity of the asphalt-rubber in each batch by the use of a rotational viscometer, in accordance with ASTM D7741. The rotational viscometer shall be furnished by the contractor or supplier. Prior to the use of each batch of asphalt-rubber, the results of the rotational viscosity testing shall meet the requirements given in Table 1009-2.

1009-3.02 Handling of Asphalt-Rubber:

Once the asphalt-rubber has been mixed, it shall be kept thoroughly agitated to prevent settling of the crumb rubber particles. The temperature of the asphalt-rubber shall be maintained between 350 and 400 degrees F.

If in the first ten hours after the completion of the reaction period the temperature of the asphalt-rubber drops below 350 degrees F, it may be reheated to a temperature between 350 and 400 degrees F.

In no case shall the asphalt-rubber be held at a temperature between 350 to 400 degrees F for more than 10 hours after the completion of the reaction period. Asphalt-rubber held for more than 10 hours shall be allowed to cool and gradually reheated to a temperature between 350 to 400 degrees F before use.

The reheating of asphalt-rubber that has cooled below 350 degrees F shall not be allowed more than one time.

Asphalt-rubber shall not be held at temperatures above 250 degrees F for more than four days after the completion of the reaction period.

For each load or batch of asphalt-rubber, the contractor shall provide the Engineer with the following documentation:

(A) The source, grade, amount and temperature of the asphalt cement prior to the addition of crumb rubber;

(B) The source and amount of crumb rubber and the crumb rubber content expressed as percent by the weight of the asphalt cement;

(C) Times and dates of the crumb rubber additions and resultant viscosity test; and

(D) A record of the temperature, with time and date reference for each load or batch. The record shall begin at the time of the addition of crumb rubber and continue until the load or batch is completely used. Readings and recordings shall be made at every temperature change in excess of 20 degrees F, and as needed to document other events which are significant to batch use and quality.

1009-4 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C) of the specifications. At the weekly meeting, the contractor shall be prepared to explain and discuss how the performance of required quality control measures will be accomplished.

The contractor shall obtain samples and perform the tests specified in Table 1009-4.

TABLE 1009-4
CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS

TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Crumb Rubber for Asphalt-Rubber			
Gradation	Arizona Test Method 714	Hot Plant	One sample per 40,000 lbs.
Asphalt-Rubber Material			
Softening Point	AASHTO T 53	Circulation Line Recommended (Point of sampling	One sample per 500 tons of asphalt rubber binder. After 1,500 tons, if results are
Resilience: 25°C (77°F)	ASTM D5329		

		specified by the Engineer.)	within specifications, frequency may be reduced to one sample for each 1,000 tons of asphalt rubber binder thereafter.
Rotational Viscosity	ASTM D7741		One sample per batch.

SECTION 1010 DRAINAGE PIPE:

1010-1 General Requirements:

Certificates of Compliance shall be furnished in accordance with the requirements of Subsection 106.05 of the specifications.

1010-2 Metal Pipe:

1010-2.01 Corrugated Metal Pipe:

Type 1A pipe, as specified in AASHTO M 36, Section 4.1.2, may be used if the shell thickness meets or exceeds the thickness specified on the plans for Type 1 pipe.

Metallic coated (zinc or aluminum) corrugated iron or steel culverts, underdrains, and spiral rib corrugated steel pipe shall conform to the requirements of AASHTO M 36, except as otherwise noted herein.

Polymer precoated, metallic coated (zinc or aluminum) corrugated steel culverts and underdrains shall conform to the requirements of AASHTO M 245, except as otherwise noted herein.

Bituminous coated corrugated metal (metallic coated steel or aluminum) culverts and underdrains shall conform to the requirements of AASHTO M 190.

Aluminum alloy corrugated metal pipe shall conform to the requirements of AASHTO M 196.

The types of bituminous coating and the type of precoated sheets to be used will be specified on the project plans. In lieu of the Type A bituminous coating, the pipe shall be coated either in the field or at the plant on the outside surface only in accordance with the requirements of AASHTO M 243. Either asphalt mastic or tar base material shall be used.

Coupling bands shall conform to the requirements of AASHTO M 36, M 245 and M 196, except that the use of bands with projections (dimples) will be limited to connection of new pipe to existing in-place pipe. Bands of special design that engage factory reformed ends of corrugated metal pipe may be used.

Bolts and nuts for all types of coupling bands shall conform to the requirements of ASTM F568.

Coupling band connection hardware consisting of nuts, bolts, rods, bars, and rivets shall be either galvanized after fabrication by the hot-dip process in accordance with the requirements of ASTM A153 or coated by the electroplating process in accordance with the requirements of ASTM B633 or ASTM B766. Components of bolted assemblies shall be galvanized in accordance with ASTM A153 separately before assembly. Special sections, such as elbows and prefabricated end sections shall conform to the applicable requirements of AASHTO M 36, M 190, M 196 and M 245.

Gaskets for all water-resistant joints shall be a continuous band or strip, at least 7 inches wide and 1/2 inch thick. Rubber for the gaskets shall conform to the requirements of ASTM D1056 for the "2A" closed cell expanded grades.

Watertight joints shall use "O"-ring gaskets. The “O”-ring gasket shall conform to the diameter dimensions specified in AASHTO M 36, Section 9.3, and conform to the technical requirements of AASHTO M 198. Watertight joints may be used when water-resistant joints are specified.

1010-2.02 Spiral Rib Metal Pipe:

Spiral rib metal pipe shall conform to the requirements specified under Subsection 1010-2.01 of the specifications for corrugated metal pipe, except as modified herein:

(A) Fabrication:

Ribbed steel pipe shall be fabricated with a continuous helical lock seam in accordance with AASHTO M 36, Type 1R or corrugation in accordance with AASHTO M 196, Type 1R. Aluminum rib pipe shall be manufactured in accordance with AASHTO M 196, Type 1R.

Each pipe end shall be fabricated with a minimum of two annular rerolled corrugations for the purposes of joining pipes together with band couplers.

(B) Coatings:

The types of coatings and the type of precoated sheets to be used shall be as specified on the project plans.

(C) Coupling Bands:

Coupling bands for spiral ribbed steel pipe shall be rerolled bands manufactured from 0.064 inch thick metallic-coated steel conforming to the requirements specified under Subsection 1010-2.01 of the specifications and shall be two-piece for pipe greater than 48 inches in diameter.

Coupling bands shall be a minimum of 10-1/2 inches wide, formed with two corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by a minimum of two 1/2 inch diameter galvanized bolts through the uses of a bar and strap suitably welded to the band. Bands may be drawn together by other means, such as angles, as approved by the Engineer.

(D) Fittings:

Fittings for ribbed steel pipe shall conform to the requirements for corrugated steel pipe fittings specified in Subsection 1010-2.01 of the specifications, except the material shall be ribbed steel.

(E) Miscellaneous:

All spiral rib manhole risers 24 inches in diameter or greater shall be reinforced with a rolled 3 inch by 3 inch by 1/4 inch angle or as approved by the Engineer.

Pipe thickness for spiral rib pipe shall be specified in the pipe summary, but shall not be less than that listed in the following tables:

SPIRAL RIB METALLIC COATED STEEL PIPE		
Pipe Diameter, Inches	**Minimum Thickness, gage**	**Corrugation Rib Size, Inches**
18 - 60	16	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
66 - 78	14	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
84 - 102	12	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2

SPIRAL RIB ALUMINUM PIPE		
Pipe Diameter, Inches	**Minimum Thickness, Gage**	**Corrugation Rib Size, Inches**
18 - 42	16	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
48 - 54	14	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
60 - 72	12	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2
78 - 84	10	3/4 by 3/4 by 7-1/2, or 3/4 by 1 by 11-1/2

1010-2.03 Concrete-Lined Corrugated Metal Pipe:

(A) Corrugated Metal Pipe:

Corrugated metal pipe, coupling bands and fittings for concrete-lined pipe shall conform to the requirements of AASHTO M 36 for the specified sectional dimensions and metallic coatings. Aluminized coating shall conform to AASHTO M 274.

Pipe shall be full circle and shall be fabricated with helical corrugations.

Pipe thickness shall be as specified in the pipe summary, but shall not be less than that listed in the following table:

Pipe Diameter, Inches	Minimum Thickness, Inches (Gage)	Corrugation Rib Size, Inches
12 - 48	0.064 (16)	2-2/3 by 1/2
54 - 72	0.064 (16)	2-2/3 by 1/2 3 by 1 5 by 1
78 - 84	0.079 (14)	2-2/3 by 1/2 3 by 1 5 by 1
90 - 102	0.109 (12)	2-2/3 by 1/2 3 by 1 5 by 1
108 - 120	0.138 (10)	3 by 1 5 by 1

Each pipe end shall be fabricated with a minimum of two annular rerolled corrugations for purposes of joining pipes together with band couplers.

Pipe shall be joined with rerolled bands made from the same material as the pipe. The bands shall be a minimum of 16 gage (0.064 inches) thick. Bands shall be two-piece for pipe greater than 48 inches in diameter.

Coupling bands shall be a minimum of 10-1/2 inches wide, formed with two corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by a minimum of two 1/2 inch diameter galvanized bolts through the use of a bar and strap suitably welded to the band. Bands may be drawn together by other means, such as angles, as approved by the Engineer.

When watertight joints are specified, "O" ring gaskets will be required. "O" ring gaskets shall be per ASTM C361 Section 5.9 and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling band, in accordance with the manufacturer's installation instructions.

(B) Concrete Lining:

(1) Composition:

Concrete for the lining shall be composed of cement, fine aggregate and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregating lining.

(2) Cement:

Portland cement shall be in accordance with Subsection 1006-2.01 of the specifications.

(3) Aggregate:

Aggregates shall conform to AASHTO M 6, except that the requirements for gradation and uniformity of gradation shall not apply.

(4) Mixture:

The aggregates shall be sized, graded, proportioned and thoroughly mixed with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the design requirements of this specification. In no case, however, shall the proportions of Portland cement plus pozzolanic admixture be less than 470 pounds per cubic yard of concrete.

(5) Lining:

The lining shall have a minimum thickness of 3/8 inch above the crest of the corrugations and shall be applied by a machine traveling through a stationary pipe. The rate of travel of the machine and the rate of concrete placement shall be mechanically regulated so as to produce a homogeneous non-segregated lining throughout. The lining shall be applied in a two-course application and shall be mechanically troweled by the lining machine as the unit moves through the pipe. The trowel attachment shall be such that the pressure applied to the lining will be uniform and shall produce a lining that has a uniform thickness and a consistent troweled finish. The vertical diameter anywhere inside the pipe must be 95 percent of the nominal diameter less acceptable tolerances as stated in AASHTO M 36. Pipe not meeting these tolerances will be rejected.

(C) Experience:

The manufacturer shall certify in writing that it has successfully manufactured and furnished corrugated steel pipe with a concrete lining per these specifications on a minimum of 15 previous projects of a storm sewer nature.

1010-3 Slotted Pipe:

Slotted pipe shall conform to the applicable requirements of AASHTO M 36. It shall be the grate slot or angle slot type. Pipe shall be helically or annular corrugated.

Grate assemblies shall be fabricated from steel conforming to the requirements of either ASTM A36 or A576 and shall be galvanized in accordance with the requirements of ASTM A123. The method of manufacture shall relieve all strain and prevent distortion of the pipe.

When a lockseam joint is used, slotted drain pipe shall be placed in a clamping device and cut the entire length prior to placement of the grate. The grate must be continuous and full depth. The grate shall be welded continuously to the pipe with a 3/16 inch fillet weld from end to end on both sides.

Bolts and nuts shall be steel conforming to the requirements of ASTM F568 and shall be galvanized in accordance with the requirements of ASTM A123.

The butyl rubber joint sealant material shall be an extruded strip or bead compounded from a nondrying, nontoxic, synthetic resin base with butyl rubber and inorganic extenders and be 100 percent solid material with no shrinkage. The sealant material shall have sufficient adhesion so that the strip or bead will adhere to galvanized steel and be soft enough to allow cold flow when compressed during connection of the pipe sections. The sealant material shall not flow or sag at temperatures up to 180 degrees F nor become brittle, crack or lose adhesion at temperatures as low as -30 degrees F and shall contain no migrating components that could leach out or produce any chemical reaction with galvanized steel. The sealant material shall be furnished in 5/8 inch by 1 inch strips or in 1 inch diameter beads on 1 inch wide release paper and wound into rolls.

An alternative joint sealant or sealing method that will provide a watertight joint may be used if approved by the Engineer.

Grout shall consist of Portland cement, aggregate, and water. It may also contain supplementary cementitious material. Portland cement, aggregate, water, and supplementary cementitious material shall conform to the requirements of Section 1006 of the specifications. If approved by the Engineer, chemical admixtures may be used. Chemical admixtures shall conform to the requirements of Subsection 1006-2.04 of the specifications, except no admixtures containing chlorides or nitrates shall be used. Air-entraining admixtures, conforming to the requirements of Subsection 1006-2.04 of the specifications, will be required for grout placed at elevations of 3,000 feet or above.

The grout shall meet the requirements given in the table below.

Minimum Cementitious Material Content: Lbs per CY (See Note 1)	**Maximum Water/Cementitious Material Ratio (w/cm): Lb./Lb.**	**Slump: Inches** (See Note 2)	**Air Content: Percent** (See Note 3)
850	0.60	9 ± 2	0 – 8

Notes:

(1) A maximum of 25 percent of the cementitious material, by weight, may consist of an approved Class F fly ash, conforming to the requirements of ASTM C618.

(2) The consistency of the grout shall be as approved by the Engineer.

(3) For placement of grout at elevations of 3,000 feet or above, the air content shall be a minimum of 4 percent and a maximum of 8 percent.

The aggregate shall consist of fine aggregate; however, at the option of the contractor, No. 8 coarse aggregate may be used in the grout. If No. 8 coarse aggregate is used, the volume shall be a maximum of 35 percent of the total aggregate volume.

For plant-mixed grout, the proportioning, mixing, and placing shall be in accordance with the applicable requirements in Section 1006 of the specifications.

For on-site mixing, grout that has been mixed more than one hour shall not be used.

Re-tempering of grout will not be permitted.

1010-4 Structural Plate Pipe:

Structural plate (steel) for pipe, pipe-arches and arches and the accessories for connecting the plates shall conform to the requirements of AASHTO M 167.

Structural plate (aluminum alloy) for pipe, pipe arches and arches and the accessories for connecting the plates shall conform to the requirements of AASHTO M 219.

When specified on the project plans or in the Special Provisions, structural plates (steel) and structural plates (aluminum alloy) shall be bituminous coated in accordance with the requirements of AASHTO M 243. Unless otherwise specified, the coating shall be applied to the outside only.

Concrete for footings, bottom slabs on paved inverts, and rings on struts shall conform to the requirements of Section 1006 of the specifications for the strength and class specified on the project plans.

Steel bars, wire, wire fabric, anchor bolts, and structural steel shall conform to the requirements of Section 1003 or 1004 of the specifications, as applicable.

1010-5 Nestable Steel Pipe:

Nestable corrugated steel pipe shall conform to the requirements of AASHTO M 36, except that the pipe shall be fabricated in two separate semi-circular sections. The two sections shall be firmly joined together in accordance with the requirements of Military Specification MIL-P-236. At the option of the contractor, the longitudinal joint of the nestable pipe sections shall be either Type I, flanged, or Type II, notched, as specified in MIL-P-236.

1010-6 Reinforced Concrete Pipe:

Reinforced concrete pipe (circular) shall conform to the requirements of AASHTO M 242 for the D-load specified.

Reinforced concrete pipe (circular) shall conform to the requirements of AASHTO M 170 for the class of pipe specified.

Reinforced concrete pipe (elliptical) shall conform to the requirements of AASHTO M 207 for the class of pipe specified.

Reinforced concrete pipe (arch) shall conform to the requirements of AASHTO M 206 for the class of pipe specified.

The contractor shall furnish the Engineer a copy of the pipe design when the standard AASHTO tables are exceeded.

Precast, reinforced concrete flared end sections shall conform to the requirements of the previously cited specifications to the extent to which they apply. The area of steel reinforcement per linear foot of the flared end section shall be at least equal to the minimum steel requirement for the reinforcement in that portion of the flared end section which abuts the pipe. Flared end sections may utilize in lieu of steel reinforcement a minimum of 5.0 pounds of macro fibers, conforming to ASTM C1116, per cubic yard of concrete mix.

Gaskets for reinforced concrete pipe (circular) joints shall conform to the requirements of AASHTO M 198 for tongue and groove ends, or AASHTO M 315 for bell and spigot types with groove or shoulder ends.

Mortar used to join reinforced concrete pipe shall be composed by volume of one part Portland cement, two parts fine aggregate, one-fifth

part hydrated lime and sufficient water to provide a plastic mixture. Cement and water shall conform to the requirements of Section 1006 of the specifications.

Fine aggregate shall conform to the grading requirements of ASTM C144. Hydrated lime shall conform to the requirements of ASTM C207, Type N. The lime shall be considered as an addition to and not as replacement for any cement.

1010-7 Nonreinforced Concrete Pipe:

Nonreinforced concrete pipe shall conform to the requirements of AASHTO M 86 for the class of pipe specified.

Gaskets and mortar used to join nonreinforced concrete pipe shall conform to the requirements hereinbefore specified under Subsection 1010-6 of the specifications.

1010-8 Thermoplastic Pipe:

Thermoplastic pipe includes corrugated high density polyethylene plastic pipe and corrugated polypropylene plastic pipe.

Corrugated high density polyethylene plastic pipe, fittings, couplings and ends, where specified, shall conform to the requirements of AASHTO M 252 for pipe sizes less than 12 inches in diameter and AASHTO M 294 for pipe sizes 12 to 60 inches in diameter.

Corrugated polypropylene plastic pipe and fittings for pipe sizes 12 to 60 inches in diameter shall conform to the requirements of AASHTO M 330 (Type C or S) and ASTM F2881.

Non-perforated pipe shall have either water resistant or watertight joints, as specified on the project plans. Watertight joints may substitute or be used when water resistant joints are required.

Water resistant joints shall be watertight according to the requirements of ASTM D3212, except that the internal water pressure test shall be conducted at 2.0 pounds per square inch, during which the joint leakage shall not exceed 200 gallons per inch of diameter per mile of pipe per day.

Watertight joints shall be watertight according to the requirements of ASTM D3212.

Tracer wire or tape, which is to be placed in the trench with the corrugated high density polyethylene plastic pipe, or corrugated polypropylene plastic pipe as an aid in location after burial, shall conform to the requirements of Subsection 104.15(B) of the specifications.

1010-9 Steel Reinforced Thermoplastic Pipe:

Steel reinforced thermoplastic pipe includes steel reinforced high density thermoplastic ribbed pipe.

Steel reinforced high density thermoplastic ribbed pipe and fittings shall conform to the requirements of ASTM F2562.

Non-perforated pipe shall have either water resistant or watertight joints, as specified on the project plans. Watertight joints may substitute or be used when water resistant joints are required.

Water resistant joints shall be watertight according to the requirements of ASTM D3212, except that the internal water pressure test shall be conducted at 2.0 pounds per square inch, during which the joint leakage shall not exceed 200 gallons per inch of diameter per mile of pipe per day.

Watertight joints shall be watertight according to the requirements of ASTM D3212.

1010-10 Metal Safety End Sections:

Metal safety end sections shall conform to the applicable requirements of AASHTO M 36.

Bolts and nuts shall be steel conforming to the requirements of ASTM A307 and shall be galvanized in accordance with the requirements of ASTM A153.

Safety and longitudinal bars shall be fabricated using schedule 40 galvanized pipe. All bars shall be galvanized after fabrication in accordance with the requirements of ASTM A123. Components of bolted assemblies shall be galvanized after fabrication in accordance with the requirements of ASTM A153 separately before assembly.

SECTION 1011 JOINT MATERIALS:

1011-1 Rubber Waterstops:

Rubber waterstops shall be either molded or extruded from plain rubber or synthetic rubber, at the option of the contractor.

The waterstops shall be formed with an integral cross section which shall be uniform within ± 1/8 inch in width and the web thickness or bulb diameter within + 1/16 and - 1/32 inch. No splices will be permitted in straight strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous and free from porosity or other defects. All junctions in the special

connection pieces shall be full-molded. During the vulcanizing period the joints shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices shall be vulcanized; mechanical, using stainless steel parts; or made with a splicing union of the same stock as the waterstop, at the option of the contractor. All finished splices shall have a tensile strength of not less than 50 percent of the unspliced material.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1011-1.01 Plain Rubber Waterstops:

Plain rubber waterstops shall be formed from stock composed of a high grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants and softeners and shall conform to the following requirements:

New Plantation Rubber Content, by volume, percent	Minimum 72
Tensile Strength (ASTM D412), psi	Minimum 3,500
Elongation at Breaking (ASTM D412), percent	Minimum 550
Unit Stresses:	
At 300 percent Elongation, psi	Minimum 1,100
At 500 percent Elongation, psi	Minimum 2,800
Shore Durometer (Hardness) (ASTM D2240)	55 to 65
Tensile Strength and Elongation at Breaking (ASTM D572), after 7 days in air at 158 ± 2 °F or after 48 hours in oxygen at 158 ± 2 °F and 300 psi = percent of original	Minimum 65

1011-1.02 Synthetic Rubber Waterstops:

Synthetic rubber waterstops shall be formed from a compound made exclusively from neoprene or SBR (styrene butadiene rubber), reinforcing carbon black, zinc oxide, polymerization agents and softeners and shall conform to the following requirements:

Neoprene or SBR Content, by volume, percent	Minimum 70
Tensile Strength (ASTM D412), psi	Minimum 2,500
Elongation at Breaking (ASTM D412), percent	Minimum 425
Shore Durometer (Hardness) (ASTM D2240)	50 to 70
Tensile Strength and Elongation at Breaking (ASTM D572), after 7 days in air at 158 ± 2 °F or after 48 hours in oxygen at 158 ± 2 °F and 300 psi = percent of original	Minimum 65

1011-2 Polyvinyl Chloride (PVC) Waterstops:

Polyvinyl chloride waterstops shall be manufactured from virgin polyvinyl chloride conforming to the requirements of the Corps of Engineers Specification Number CRD-C572.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted stating that the requirements specified under paragraph six of CRD-C572 have been complied with.

Field splices shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. The heat shall be sufficient to melt but not char the plastic.

1011-3 Joint Sealant (Hot-Applied):

Joint sealant material, including asphalt-rubber sealants, shall be a hot-applied type, conforming to the requirements of ASTM D6690, Type II or Type III. Joint sealant shall not contain any coal-tar materials.

The following requirement shall be added to the “Packaging and Package Marking” requirements of ASTM D6690:

> The minimum ambient temperature during application and ambient temperatures under various storage conditions shall be clearly marked on the container.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1011-4 Joint Sealant (Cold-Application):

Joint sealant shall be cold-application, mastic, single- or multiple-component type.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1011-5 Bridge Deck Joint Seals:

The elastomer for joint seal elements shall be polychloroprene rubber (Neoprene) and shall be compatible with concrete and shall be resistant to abrasion, oxidation, aging and sunlight, and to oils, gasoline, salt and other materials that may be spilled on or applied to the surface.

Joint seals shall be of the cellular compression type or strip type.

One piece of the material supplied shall be at least 18 inches longer than required by the plans and the additional length will be removed by the Engineer and used for testing by ADOT Materials Group.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1011-5.01 Compression Seals:

Compression seals shall consist of a prefabricated preformed elastomer joint seal material and shall conform to the requirements of ASTM D3542.

The seal shall consist of a multi-channel nonporous, homogeneous material furnished in a finished extruded form.

The minimum depth of the seal, measured at the contact surface, shall be at least 95 percent of the minimum uncompressed width of the seal as designated by the manufacturer.

The joint seal shall provide a Movement Rating (MR) of not less than that shown on the plans. The seal shall be so formed that it can be compressed to 40 percent of its original width without damage while simultaneously maintaining the top center of the exposed surface below the top surface of the installed joint.

The top and bottom edges of the joint seal shall maintain continuous contact with the side of the armor over the entire range of joint movement.

The compression seal shall be furnished full length except as otherwise specified on the project plans and as indicated on Standard Drawing B-24.20.

At all open ends of the seal that would admit water or debris, each cell shall be filled to a depth of 3 inches with commercial quality open cell polyurethane foam or closed by other means subject to the approval of the Engineer.

The seal element shall be installed in strict accordance with the manufacturer's recommendations, subject to these specifications and

the approval of the Engineer, using equipment manufactured specifically for the installation of said element. The equipment shall not cause structural damage to either the seal element or the joint armor and shall not twist, distort, or cause other malformations in the installed seal element. Contact surfaces of the seal element shall be cleaned with normal butylacetate, using clean rags or mops, immediately prior to application of lubricant adhesive and sealant. The lubricant adhesive and sealant shall be applied to the seal element and joint armor contact surfaces at the rate recommended by the manufacturer.

If the required joint opening at the time of installation is inadequate to allow for easy installation of the seal element, the compression seals shall be shop installed into deck joint assemblies to be shipped fully assembled and installed as a unit. Fully assembled units shall have the lubricant adhesive applied to the seal and armor contact surfaces and shall be equipped with shipping and temperature adjustment devices approved by the Engineer.

The lubricant adhesive and sealant shall conform to the provisions of ASTM D4070.

The lubricant adhesive and sealant shall have a viscosity such that it will perform suitably with installation equipment, remaining fluid from 5 degrees F to 120 degrees F.

Each lot of lubricant adhesive and sealant shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture. The shipping containers shall also indicate any special precautions or instructions required because of product toxicity, flammability, or other such information pertinent to the proper storage and use of the product.

1011-5.02 Strip Seals:

Strip seals shall be preformed non-reinforced, polychloroprene strip seal glands that mechanically lock into steel retainers. The steel retainers shall be anchored into the structure in accordance with the contract requirements.

The adhesive lubricant used to install the strip seal gland into the locking steel retainer shall be a one part moisture curing polyurethane compound, meeting the requirements of ASTM D4070.

The strip seal gland shall be delivered to the jobsite in lengths suitable for continuous one-piece installation for each individual expansion joint. Field splicing is not permitted.

All steel surfaces that come in contact with the strip seal gland shall be cleaned to meet the requirements of SSPC-SP6.

Special conditions such as mitres, tees, and crosses shall be shop fabricated in a mold under heat and pressure.

Strip seal gland installation at joint openings of less than 1-1/2 inches will not be permitted.

The elastomer for strip seal elements shall conform to the requirements of ASTM D3542 modified as follows:

(A) Recovery testing is excluded; and

(B) TABLE 1 of ASTM D3542 is revised as follows:

TABLE NO. 1
PHYSICAL PROPERTIES FOR PREFORMED ELASTOMER STRIP SEALS

Property	Require-ment	ASTM Test Method
Tensile strength, minimum psi	2000	D412
Elongation at break, min. %	250	D412
Hardness, Type A durometer, points	60 ± 5	D2240 (Modified) (1, 3)
Oven aging, 70 hr at 212 °F		D573
Tensile strength, loss, max. %	20	
Elongation, loss, max. %	20	
Hardness, Type A durometer, points change	0 to + 10	D2240 (Modified) (1, 3)
Oil swell, ASTM Oil No. 3, 70 hr at 212 °F, weight change, max. %	45	D471
Ozone resistance, 20 % strain, 300 pphm in air, 70 hr at 104 °F	No Cracks	D1149 (Modified) (2)
Low temperature stiffening 7 days at 14 °F; Hardness, Type A durometer, points change	0 to +15	D2240 (Modified) (1, 3)
Compression set, 70 hr at 212 °F, maximum %	40	D395 Method B (Modified) (1)

Notes:

(1) The term "modified" in the table relates to the specimen preparation. The use of the strip seal as the specimen source requires that more plies than specified in either of the modified test procedures be used. Such specimen modification shall be agreed upon by the purchaser and producer or supplier prior to testing.

(2) Test in accordance with procedure A of ASTM D518 and ozone concentration is expressed in pphm.

(3) The hardness test shall be made with the durometer in a durometer stand as recommended in ASTM D2240.

1011-6 Preformed Expansion Joint Filler:

Preformed expansion joint filler for concrete structures, pavements and incidental items shall conform to the requirements on the plans. When not specified, one of the following joint fillers may be used.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1011-6.01 Bituminous Joint Filler:

Bituminous joint filler shall conform to the requirements of AASHTO M 213.

1011-6.02 Nonbituminous Joint Filler:

Nonbituminous joint filler shall conform to the requirements of AASHTO M 153, Type II, with the following modifications. The joint filler may be formed as a premolded strip from suitable fibers. The compression test specimen of the premolded fiber joint filler shall recover to at least 65 percent of its thickness before testing.

1011-6.03 Semi-rigid, Closed-cell Polypropylene Foam, Preformed Expansion Joint Filler:

Semi-rigid, closed-cell polypropylene foam, preformed expansion joint filler, shall conform to the requirements of ASTM D8139.

1011-7 Cellular Plastic Joint Filler:

Cellular plastic joint filler shall conform to the requirements of ASTM D3204. The lubricant-adhesive shall be furnished by the manufacturer and used according to its recommendations.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1011-8 Silicone Joint Sealant:

1011-8.01 General Requirements:

Silicone joint sealant shall be a low modulus silicone that is specifically formulated to seal Portland cement concrete pavement joints. Silicone sealant shall be furnished in a one part formulation which is non acid-curing, and shall conform to the requirements of ASTM D5893, except as specified herein.

1011-8.02 Packaging and Marking:

The sealant shall be delivered in the manufacturer's original sealed container. Each container shall have attached, intact, the original manufacturer's label. The label shall be tamper-proof, non-removable and shall be legibly marked with the manufacturer's name, the trade name of the sealant, the manufacturer's batch or production lot number, and the expiration date of the manufacturer's shelf life warranty. Sealant that has exceeded the shelf life warranty expiration date shall not be used unless it has been retested and recertified for bond test method in conformance with ASTM D5893. The sealant may be recertified for a period not exceeding six months from the date of retesting. Retesting or replacement of the sealant will be at the contractor's option. Retesting will be at no additional cost to the Department. Failure to meet specification requirements shall not be cause for claim or extension of the contract. The contractor shall be held liable for all costs incurred in procuring and testing of materials that are found to be outside specification requirements.

1011-8.03 Field Performance:

The manufacturer of the joint sealant shall demonstrate satisfactory field performance in Arizona, or by AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) field evaluation, of less than 1 percent total failure (either within the material or the adhesive bond to the joint face) after one year of service, before the material shall be used.

1011-8.04 Acceptance:

Only those sealants shown on the Department's Approved Products List (APL) shall be used. Copies of the most current version of the APL are available on the internet from the Arizona Transportation Research Center (ATRC), through its Product Evaluation Program. In addition, a Certificate of Analysis conforming to the requirements of Subsection 106.05 of the specifications shall accompany each lot or batch of sealant. No joint sealant shall be used until the Engineer has approved the material for placement.

SECTION 1012 GUARDRAIL MATERIALS:

1012-1 General Requirements:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the specifications shall be submitted.

1012-2 Fasteners, Rail Elements, Posts, and Blockouts:

Guardrail fasteners, rail elements, posts, blockouts, and other components shall conform to the requirements of Task Force 13 "Guide to Standardized Roadside Hardware". Rail elements shall be galvanized

after fabrication, with fabrication to include forming, cutting, shearing, punching, drilling, bending, welding, and riveting.

Unless otherwise specified, all surfaces of guardrail elements which are exposed to traffic shall present a uniform, pleasing appearance and shall be free of scars, stains or corrosion.

1012-3 Materials:

1012-3.01 Miscellaneous:

Nails shall be 16-penny common, galvanized. Nails for retainer strap shall be 10-penny common, galvanized.

Nuts, bolts, and washers to be used in installations for which the details are not shown on the plans or in the Task Force 13 “Guide to Standardized Roadside Hardware” publication shall conform to the requirements of ASTM F568 or A307; be galvanized in accordance with the requirements of ASTM A153, Class C; and conform to the dimensional requirements of the American National Standards Institute.

Structural steel shapes, plates, bars and strips used in fabrication of hardware and all miscellaneous steel shall conform to the requirements of ASTM A36 and shall be galvanized in conformance with the appropriate requirements of AASHTO M 111 and M 232. They shall meet the dimensional requirements of The American Institute of Steel Construction.

Round and square structural steel tubing shall conform to the material requirements of either ASTM A500 or A501 and shall be galvanized in accordance with the requirements of AASHTO M 180, Type 1.

Where galvanizing has been damaged, the coating shall be repaired by applying two coats of zinc-rich primer conforming to the requirements of Section 1002 of the specifications.

1012-3.02 Timber Guardrail, Posts, and Blockouts:

Stress grading for timber posts and blockouts shall conform to the requirements of AASHTO M 168 and may be rough sawn (unplaned) or surfaced four sides (S4S) with the nominal dimensions indicated in the contract documents.

Only one type of post and blockout shall be used for any one continuous length of guardrail.

Timber shall be No. 1 or better, and the stress grade shall be 1,200 pounds per square inch or higher.

At the time of installation, the dimensions of timber posts and blockouts shall not vary more than ± 1/4 inch from the nominal dimensions as hereinbefore specified.

1012-3.03 Timber Preservation Treatment and Fabrication:

All timber shall have a preservative treatment and be marked in accordance with the requirements of AASHTO M 133, American Wood Protection Association (AWPA) Standard U1, UC4B "Commodity Specification A: Sawn Products", and AWPA Standard T1.

Drilling or fabrication should be done where possible before the preservation treatment process. In event of a mechanical injury or field cutting, field treatment shall be in accordance with AWPA Standard M4.

The inspection at the wood preservation plant for posts and blocks shall conform to the requirements of AWPA M2.

1012-4 Acceptance of Timber Guardrail Posts and Blockouts:

In the absence of an American Lumber Standard Committee (ALSC) grade mark, the responsibility for acceptance of the posts and blocks for grade will be that of the Engineer.

The contractor shall submit to the Engineer the manufacturer's Certificate of Compliance conforming to the requirements of Subsection 106.05 of the specifications. The certificate shall be furnished by the post and block supplier and shall also include the following information:

(A) The species or species group of timber and grade; and

(B) Preservative treatment documentation including the quantities of each item furnished listed with date of treatment and retention analysis results by lot number.

When required by ADOT, third-party certificates of inspection shall be issued by an (ALSC) or an International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Standard 17020 accredited third-party inspection agency. Where certificates of treatment are required, third-party agency quality marks or certification marks shall be legibly applied to each piece of treated material and shall reference the corresponding, applicable product descriptions, tally and minimum treatment requirements as specified in the project plans and be provided by the material supplier.

SECTION 1013 BEARING PADS:

1013-1 Preformed Fabric Pads:

Preformed fabric pads shall be composed of multiple layers of 8-ounce cotton duck impregnated and bound with high quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 pounds per square inch without detrimental reduction in thickness or extrusion.

Preformed fabric pad samples will be tested by the Department.

The manufacturer certification and sampling shall conform to the requirements of Subsection 1013-3 of the specifications.

1013-2 Elastomeric Bearing Pads:

1013-2.01 General:

The work shall consist of furnishing and installing elastomeric bearing pads. Bearings shall be constructed in accordance with the details shown on the plans and as specified in these specifications.

Prior to shipment from the point of manufacture, bearings shall be packaged in such manner to ensure that during shipment and storage the bearings will be protected against damage from handling, weather, or any normal hazard. All bearings shall be stored at the work site in an area that provides protection from environmental and physical damage. When installed, bearings shall be clean and free of all foreign substances.

Bearings shall be installed to the positions and orientations shown on the plans. Bearings shall be set level, in exact positions, and must have full and even bearing on all bearing planes. Bearings surfaces located at improper elevations or set not level and true to plane shall be corrected prior to placement of bearings. Elastomeric bearing pads shall be set directly on properly prepared concrete surfaces without bedding material.

Elastomeric bearing pads shall include unreinforced pads (consisting of elastomer only) and reinforced bearings with steel or fabric laminates.

Bearings shall be furnished with the dimensions, material properties and elastomer grade required by the plans. Unless otherwise specified on the plans, bearings which have thicknesses greater than 1/2 inch shall be reinforced with steel or fabric laminates. The design method (A or B) and the design load shall also be shown on the plans, and testing shall be performed accordingly. In the absence of more specific

information, bearings shall be Grade 3, shall be an elastomer with 130 pounds per square inch shear modulus (55 durometer hardness).

1013-2.02 Material Properties:

The sole polymer in the elastomeric compound shall be neoprene and shall be not less than 60 percent, by volume, of the total compound. The elastomer compound shall be classified as being of low temperature Grade 0, 2, or 3. The grades are defined by the testing requirements in Table 1013-1. A higher grade of elastomer, signified by a larger grade number, may be substituted for a lower one.

The elastomer compound shall meet the minimum requirements of Table 1013-1, except as otherwise specified by the Engineer. Test requirements may be interpolated for intermediate hardness. The material will be specified by its shear modulus whose measured value shall lie within 15 percent of the specified value. A consistent value of hardness shall also be supplied for the purpose of defining limits for the tests in Table 1013-1. Laminated bearings shall have a shear modulus not greater than 200 pounds per square inch. When test specimens are cut from the finished product, the physical properties shall be permitted to vary by 10 percent from those specified in Table 1013-1. All material tests shall be carried out at 73 ± 4 degrees F, unless otherwise noted. Shear modulus tests shall be carried out using the apparatus and procedures described in Annex A1 of ASTM D4014.

Certification, sampling, and testing shall conform to the requirements of Subsection 1013-3 of the specifications.

Table 1013-1
ELASTOMERIC COMPOUND REQUIREMENTS

Note that ASTM D1043 refers to "modulus of rigidity" while ASTM D4014 refers to "shear modulus." The word "stiffness" is used here to cover both terms.

Physical Properties				
D2240	Hardness: Shore A Durometer	45 to 75		
		45 to 55	56 to 65	66 to 75
D412	Ultimate Elongation: min. %	400	350	300
	Tensile Strength: min. psi	2250		
Heat Resistance				
D573: 70 hours at 212 °F	Change in Durometer Hardness: maximum points	15		
	Change in Tensile Strength: maximum %	-15		
	Change in Ultimate Elongation: maximum %	-40		
Compression Set				
ASTM D395, Method B	22 hr at 212°F: maximum %	35		

Table 1013-1 ELASTOMERIC COMPOUND REQUIREMENTS		
Ozone		
ASTM D1149	100 pphm ozone in air by vol., 20 % strain, 100 ± 2°F, 100 hr, mounting IAW ASTM D1149 (Procedure A)	No Cracks
Low Temperature Brittleness		
D746 Procedure B	Grade 0: No Test Required Grade 2: No Test Required Grade 3: Brittleness at -40°F	- - No Failure
Instantaneous Low Temperature Thermal Stiffening		
ASTM D1043	Grade 0: Tested at -25°F Grade 2: Tested at -25°F Grade 3: Tested at -40°F	(1) (1) (1)
Low Temperature Crystallization		
ASTM D4014 Quad Shear Test As Described in Annex A	Grade 0: No Test Required Grade 2: 7 Days at 0°F Grade 3: 14 Days at -15°F	(2) (2) (2)

Notes:

(1) Stiffness at test temperature shall not exceed four times the stiffness measured at 73 °F.

(2) Stiffness at test time and temperature shall not exceed four times the stiffness measured at 73°F with no time delay. The stiffness shall be measured with a quad shear test rig in an enclosed freezer unit. The test specimens shall be taken from a randomly selected bearing. A ± 25 % strain cycle shall be used, and a complete cycle of strain shall be applied with a period of 100 seconds. The first 3/4 cycle of strain shall be discarded, and the stiffness shall be determined by the slope of the force deflection curve for the next 1/2 cycle of loading.

1013-2.03 Plain and Fabric-Reinforced Elastomeric Bearing Pads:

Pads less than or equal to 1/2 inch in thickness shall be all elastomer. Pads greater than 1/2 inch thick shall be laminated.

Laminated pads shall consist of alternate layers of elastomer and fabric reinforcement bonded together. The top and bottom layers of reinforcement shall be uniformly covered with a layer of elastomer. The thickness of elastomer cover shall be allowed per tolerances listed in Table 1013-2.

Laminated pads shall have reinforcement every 1/2 inch through the entire thickness. Fabric reinforcement shall be single-ply at top and bottom surfaces of the pad and double-ply within the pad. Fabric shall be free of folds and ripples and shall be parallel to the top and bottom

surfaces. Variations in the location of the reinforcement from its theoretical location in excess of the specified Fabrication Tolerances will be cause for rejection.

Pads of all-elastomer or with fabric reinforcement may be cut from large sheets. Cutting shall be performed in such a manner as to avoid heating of the material, to produce a smooth edge with no tears or other jagged areas, and to cause as little damage to the material as possible. The cutting method shall not cause any separation of the fabric from the elastomer for laminated bearings.

Flash tolerance, finish, and appearance shall meet the requirements of the latest edition of the Rubber Handbook published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

The bond between elastomer and fabric shall be such that when a sample is tested for separation, it shall have a minimum peel strength of 30 pounds per inch of width.

Fabric reinforcement shall be woven from 100 percent glass fibers of E-type yarn with continuous fibers. The minimum thread count in either direction shall be 25 threads per inch. The fabric shall have either a crowfoot or an 8 Harness Satin weave. Each ply of fabric shall have a breaking strength of not less than 800 pounds per inch of width in each thread direction when 3 inch by 36 inch samples are tested on split drum grips. The bond between double plies shall have a minimum peel strength of 20 pounds per inch of width. Holes in the fabric will not be permitted.

At the contractor's option, steel-reinforced elastomeric bearing pads may be furnished in lieu of fabric-reinforced elastomeric bearing pads that are 1/2 inch and over in thickness.

1013-2.04 Steel Reinforced Elastomeric Bearing Pads:

For steel-reinforced elastomeric bearings, the edges of the steel shall be protected at all times from corrosion. Steel-reinforced elastomeric bearing pads shall conform to the requirements for steel-laminated elastomeric bearings as specified in ASTM D4014 and the following:

(A) The thickness of each bearing pad shall be as shown on the project plans. The bearings shall consist of (N-1) internal elastomer laminates and N steel laminates, where N is equal to the bearing pad thickness in inches shown on the project plans divided by 1/2 inch. The steel laminates shall be 11 gage and shall be spaced every 1/2 inch, center-to-center. The top and bottom steel laminates shall have 1/4 inch of elastomer cover as measured from the center of the steel laminate to the pad surface;

(B) The elastomer clear cover thickness from the surface to the steel laminates at the sides of the bearings shall be 1/8 inch. If guide pins or other devices are used to control the side cover over the steel laminates, any exposed portions of the steel laminates shall be sealed by vulcanized patching;

(C) Steel laminates used for reinforcement shall be made from rolled mild steel conforming to ASTM A36, ASTM A1011, or ASTM A1008, Grade 40. Holes in plates for manufacturing purposes will not be permitted unless they have been accounted for in the design, as shown on the plans;

(D) Bearings with steel laminates shall be cast as a unit in a mold and shall be bonded and vulcanized under heat and pressure. The mold finish shall conform to standard shop practice. The internal steel laminates shall be sandblasted and cleaned of all surface coatings, rust, mill scale, and dirt before bonding, and shall be free of sharp edges and burrs. External load plates (sole plates) shall be protected from rusting by the manufacturer, and, preferably, shall be hot bonded to the bearing during vulcanization. Bearings that are designed to act as a single unit with a given shape factor must be manufactured as a single unit; and

(E) Steel laminated bearings shall develop a minimum peel strength of 40 pounds per inch of width.

1013-2.05 Fabrication Tolerances:

Plain and laminated bearing pads shall be built to the specified dimension within the tolerances listed in Table 1013-2.

Table 1013-2
FABRICATION TOLERANCES

Parameters	Tolerances	
	Minus	Plus
1. Overall Height:		
Design Thickness 1-1/4 inch or less	0	+1/8 inch
Design Thickness over 1-1/4 inch	0	+1/4 inch
2. Overall Horizontal Dimensions:		
36 inches or Less	0	+1/4 inch
Over 36 inches	0	+1/2 inch
3. Thickness of Individual Layers of Elastomer at any Point within the Bearing	± 20 % of Design Value but no more than ± 1/8 inch	
4. Parallelism with Opposite Face:		
Top and Bottom	0.005 Radians	
Sides	0.02 Radians	
5. Position of Exposed Connection Members, Holes, Slots, or Inserts	± 1/8 inch	

Table 1013-2 FABRICATION TOLERANCES		
6. Edge Cover: Embedded Laminates or Connection Members	0	+1/8 inch
7. Thickness: Top and Bottom Cover Layer (if required)	0	+1/8 inch
8. Size: Holes, Slots, or Inserts	± 1/8 inch	

1013-3 Certification and Testing:

1013-3.01 General Requirements:

(A) General:

A lot shall consist of a single type of bearing of the same design, material and thickness, delivered to the project site at the same time. Unless otherwise specified on the plans, certification and testing shall be as described in Subsections 1013-3.01(B) and (C) of the specifications.

(B) Quality Control Testing by Manufacturer:

The contractor shall furnish the Engineer with Certificates of Analysis from the manufacturer, conforming to the requirements of Subsection 106.05 of the specifications.

Each reinforced bearing shall be marked in indelible ink or flexible paint. The marking shall consist of the order number, lot number, bearing identification number, and elastomer type and grade number. The marking shall be on the face that is visible after erection of the bridge structures.

The ambient temperature tests on the elastomer described in Subsection 1013-3.02(A) of the specifications shall be conducted for the materials used in each lot of bearings. In lieu of performing a shear modulus test for each batch of material, the manufacturer may elect to provide certificates from tests performed within the preceding year on identical formulations.

All three low temperature tests described in Subsection 1013-3.02(C) of the specifications shall be conducted on Grade 3 material used in each lot of bearings, with the following exception. In lieu of the low temperature crystallization tests on each lot of bearings to be used, the manufacturer may choose to provide Certificates of Analysis from low-temperature crystallization tests performed within the preceding year on identical Grade 3 material.

Every finished bearing shall be visually inspected in accordance with Subsection 1013-3.02(C) of the specifications.

Every steel reinforced bearing shall be subjected to the short-term load test described in Subsection 1013-3.02(D) of the specifications.

From each lot of bearings designed by Method B of AASHTO LRFD Bridge Specifications Article 14.7.5, a random sample shall be subjected to the long-term load test described in Subsection 1013-3.02(E) of the specifications. The sample shall consist of at least one bearing chosen randomly from each size and material batch and shall comprise at least 10 percent of the lot. If one bearing of the sample fails, all the bearings of that lot shall be rejected, unless the manufacturer elects to test each bearing of the lot at no additional cost to the Department. In lieu of this random sampling procedure, the Engineer may require every bearing of the lot to be tested.

(C) Acceptance Testing:

A minimum of two sample pads from every 100 pads furnished, or portion thereof, will be selected at random by the Engineer at the project site for testing. A minimum of one sample pad will be selected from each lot. Bearing pads marked or otherwise presented to the Department as being test pads shall not be tested. Samples shall consist of complete pads as detailed on the project plans and as specified herein. The contractor shall furnish additional complete pads to replace those taken for testing. Pads shall be available for testing at least three weeks in advance of intended use.

Acceptance testing shall be performed by a laboratory listed in the ADOT Directory of Approved Testing Laboratories on the Department's website.

The contractor shall, at no additional cost to the Department, have the elastomeric bearing pad samples tested by an approved testing laboratory. The testing laboratory shall be approved by the Engineer, shall not be affiliated with the bearing pad manufacturer, and shall be under the supervision of a registered professional engineer.

The contractor shall furnish the Engineer with Certificates of Analysis, conforming to the requirements of Subsection 106.05 of the specifications, from the approved testing laboratory certifying that the bearings tested conform to the specified requirements for dimensional tolerances and material properties. The following tests shall be performed as appropriate and be supported with Certificates of Analysis:

(1) Ambient temperature test;
(2) Heat resistance test;
(3) Visual inspection;
(4) Shear modulus test; and
(5) Bond and peel strength tests

The heat resistance tests shall be performed in accordance with Subsection 1013-3.02(B) of the specifications.

Shear stiffness tests shall be performed on material from a random sample of the finished bearings in accordance with Subsection 1013-3.02(F) of the specifications.

1013-3.02 Testing Requirements:

(A) Ambient Temperature Tests on the Elastomer:

The elastomer used shall satisfy the limits prescribed in Table 1013-1 for durometer hardness, tensile strength, and ultimate elongation. The bond to the reinforcement, if any, shall also satisfy the bond requirements in Subsection 1013-2.03 or 1013-2.04 of the specifications and shall be tested in accordance with ASTM D429, Method B. The shear modulus of the material shall be tested at 73 degrees F using the apparatus and procedure described in Annex A1 of ASTM D4014. The shear modulus shall fall within 15 percent of the specified value.

(B) Heat Resistance Tests on the Elastomer:

The elastomer shall satisfy the limits prescribed in Table 1013-1 for the change in durometer hardness, change in tensile strength, and change in ultimate elongation, as well as for compression set and ozone.

(C) Visual Inspection of the Finished Bearing:

Every finished bearing shall be inspected for compliance with dimensional tolerances and for overall quality of manufacturing.

(D) Short-Duration Compression Tests on Bearings:

The bearing shall be loaded in compression to 1.5 times its maximum design load. That load shall be held constant for five minutes, removed, and reapplied for another five minutes. The bearing shall be examined visually while under the second loading. If the bulging pattern suggests layer thickness or parallelism outside the specified tolerances or a poor laminate bond, the bearing shall be rejected. If there are three or more separate surface cracks greater than 0.08 inches wide and 0.08 inches deep, the bearing shall be rejected.

(E) Long-Duration Compression Tests on Bearings:

The bearing shall be loaded in compression to 1.5 times its maximum design load for a minimum period of 15 hours. If, during the test, the load falls below 1.3 times the maximum design load, the test duration shall be increased by the period of time for which the load is below this limit. The bearing shall be examined visually at the end of the test while it is still under load. If the bulging pattern suggests layer thickness or parallelism outside the specified tolerances or a poor laminate bond, the bearing shall be rejected. If there are three or more separate surface cracks greater than 0.08 inches wide and 0.08 inches deep, the bearing shall be rejected.

(F) Shear Modulus Tests on Material From Bearings:

The shear modulus of the material in the finished bearing shall be evaluated by testing a specimen cut from it using the apparatus and procedures described in Annex A1 of ASTM D4014, or, if directed by the Engineer, a comparable nondestructive stiffness test may be conducted on a pair of finished bearings. The shear modulus shall fall within 15 percent of the specified value. If the test is conducted on finished bearings, the material shear modulus shall be computed from the measured shear stiffness of the bearings, taking account of the influence on shear stiffness of bearing geometry and compressive load.

(G) Bond and Peel Strength Tests:

Cold bonding between individual laminated pads, if used, shall be tested in accordance with the requirements of California Test Method 663.

The peel strength test shall be performed in accordance with ASTM D429, Method B, for both fabric and steel reinforced pads.

1013-4 Installation:

Bearings shall be placed on surfaces that are plane to within 1/16 inch and horizontal to within 0.01 radians. Exterior plates of the bearing shall not be welded unless at least 1-1/2 inches of steel exists between the weld and the elastomer. In no case shall the elastomer or the bond be subjected to temperatures higher than 400 degrees F.

SECTION 1014 GEOSYNTHETICS:

1014-1 General Requirements:

Certificates of Analysis, conforming to the requirements of Subsection 106.05 of the specifications, shall be submitted.

Geosynthetic materials, including eligible biaxial geogrid, must be on the DataMine list for geotextiles and geosynthetics on the AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) website. The product line evaluation report from AASHTO Product Evaluation & Audit Solutions (formerly NTPEP) shall be provided to the Engineer prior to use on the project.

Fibers, yarns, and filaments used in the manufacture of geotextile fabric, and the threads used in joining by sewing, shall consist of long-chain synthetic polymers, composed at least 95 percent, by weight, of polyolefins or polyesters. They shall be formed into a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

Geosynthetic materials shall be furnished in protective covers capable of protecting the materials from harmful environmental conditions such as ultraviolet rays, abrasion, extreme heat, and water. Storage of the materials shall be in a manner that prevents damage, contamination, or deterioration.

Geotextile fabric shall be resistant to chemical attack, rot, and mildew, and shall have no tears or defects which will adversely alter its physical properties.

All numeric values in the following tables, except for apparent opening size (AOS), represent minimum average roll values (MARV) in the weaker principal direction. Numeric values for (AOS) represent maximum average roll values.

Woven slit film geosynthetics will not be allowed for use in Subsections 1014-5, 1014-6, 1014-7, and 1014-9 of the specifications.

1014-2 Pavement Fabric:

The pavement fabric shall be specifically designed for the designated pavement application, as a waterproofing and stress relieving membrane between two successive asphalt layers.

The width of the fabric shall be appropriate for the proposed construction. Pavement fabric shall meet the requirements of the following table:

Pavement Fabric Requirements		
Property	**Requirement**	**Test Method**
Mass per unit area: oz./sq. yd.	4.0	ASTM D5261
Grab strength: lb.	100	ASTM D4632
Ultimate Elongation: %	≥ 50	ASTM D4632
Melting point: degrees F	300	ASTM D276
Asphalt Retention: gal./sq. yd.	(Notes 1 and 2)	ASTM D6140

Notes:

(1) Asphalt is required to saturate paving fabric only. Asphalt retention must be provided in the manufacturer certification. Value does not indicate the asphalt application rate required for construction.

(2) Product asphalt retention property must meet the MARV value provided by the manufacturer certification.

1014-3 Geogrid:

Geogrid reinforcement material for roadway base applications shall be a bi-axial polymer grid structure, specifically fabricated for use as a

base reinforcement. The width of the geogrid shall be approximately 13 feet or as appropriate for the proposed construction. The geogrid shall be one of the following structure types:

(A) A structure comprised of punched and drawn polypropylene sheet to form a grid; or

(B) A structure comprised of polypropylene extruded to form a grid.

(C) A structure comprised of polypropylene integrally formed by extruding then stretching longitudinally and transversely to form a grid.

The geogrid material shall additionally conform to the requirements shown in the table below:

Geogrid Requirements			
Property	**Requirement**		**Test Method**
	MD (Note 2)	**XMD** (Note 3)	
Average Aperture Size: inch	0.8 – 1.5	0.8 – 1.5	I.D. Calipered (Note 1)
Rib Thickness: inch	0.05	0.05	ASTM D1777
Tensile Strength: lb./ft. At 2% Strain At 5% Strain Ultimate Tensile Strength	 410 810 1,310	 620 1,340 1,970	ASTM D6637
Flexural Rigidity: mg-cm	750,000		ASTM D7748
Junction Efficiency: %	93		ASTM D7737
Resistance to UV Degradation: %	100		ASTM D4355

Notes:

(1) Maximum inside dimension in each principal direction measured by calipers.

(2) MD: Machine direction which is along roll length.

(3) XMD: Cross machine direction which is across the roll width.

1014-4 Separation Geotextile Fabric:

The physical requirements for the separation fabric will be determined by the survivability rating called out for the fabric in the Special Provisions or as shown on the project plans. Requirements for each survivability rating are listed herein and in Subsections 1014-4.01, 1014-4.02, and 1014-4.03 of the specifications.

Separation geotextile fabric shall meet the following requirements:

Property	Non-Woven	Test Method
Permittivity: sec^{-1}	0.5	ASTM D4491
Apparent opening size: U.S. Standard sieve size	No. 70	ASTM D4751

1014-4.01 Low Survivability Fabric:

Low survivability fabric shall additionally meet the following requirements:

Low Survivability Separation Fabric Requirements		
Property	**Non-Woven** **Elongation ≥50%** (Note 1)	**Test Method**
Grab strength: lb.	112	ASTM D4632
Tear strength: lb.	40	ASTM D4533
Puncture Strength: lb.	223	ASTM D6241
Ultraviolet Stability (retained strength):	≥ 50% after 500 hours exposure	ASTM D4355
Note: (1) As measured in accordance with ASTM D4632.		

1014-4.02 Moderate Survivability Fabric:

Moderate survivability fabric shall additionally meet the following requirements:

Moderate Survivability Fabric Requirements		
Property	**Non-Woven** **Elongation ≥50%** (Note 1)	**Test Method**
Grab strength: lb.	157	ASTM D4632
Tear strength: lb.	56	ASTM D4533
Puncture strength: lb.	309	ASTM D6241
Ultraviolet stability (retained strength):	≥ 50% after 500 hours exposure	ASTM D4355
Notes: (1) As measured in accordance with ASTM D4632. (2) The required MARV tear strength for woven monofilament geotextiles is 56 lb.		

1014-4.03 High Survivability Fabric:

High survivability fabric shall additionally meet the following requirements:

High Survivability Fabric Requirements		
Property	**Non-Woven** **Elongation ≥50%** (Note 1)	**Test Method**
Grab strength: lb.	202	ASTM D4632
Tear strength: lb.	79	ASTM D4533
Puncture strength: lb.	433	ASTM D6241
Ultraviolet stability (retained strength):	≥ 50% after 500 hours exposure	ASTM D4355
Note: (1) As measured in accordance with ASTM D4632.		

1014-5 Bank Protection Fabric:

Bank protection fabric shall meet the following requirements:

Bank Protection Fabric Requirements		
Property	**Non-Woven** **Elongation ≥50%** (Note 1)	**Test Method**
Grab strength: lb.	202	ASTM D4632
Tear strength: lb.	79	ASTM D4533
Puncture strength: lb.	433	ASTM D6241
Ultraviolet stability (retained strength):	≥ 50% after 500 hours exposure	ASTM D4355
Permittivity: sec^{-1}	0.7	ASTM D4491
Apparent opening size: U.S. Standard sieve size	No. 70	ASTM D4751
Note: (1) As measured in accordance with ASTM D4632.		

1014-6 Geocomposite Wall Drain System:

The geocomposite wall drain system shall be of composite construction, consisting of a supporting structure of drainage core material and a geotextile filter fabric permanently bonded to the core material on one side only. The geocomposite shall be resistant to commonly encountered chemicals and hydrocarbons, and resistant to ultraviolet exposure.

1014-6.01 Geocomposite Wall Drain Core:

The geocomposite wall drain core material shall consist of a preformed, stable, polymer plastic material with a cuspated, nippled, or geonet structure. The drainage core shall provide support for and shall be bonded to the geotextile filter fabric at intervals not exceeding 1-1/8 inches in any direction. Its preformed structure shall be perforated to allow water to flow freely to the weep hole drainage outlets. If not

perforated during manufacture, the core shall be perforated in the field at the weep hole drainage outlet locations. The core shall have at least 14 square inches per square foot of flat area in contact with the geotextile fabric to support the fabric. The core material shall additionally conform to the following physical requirements:

Geocomposite Wall Drain Core Requirements		
Property	**Requirement** (Note 1)	**Test Method**
Thickness with Fabric: inch	0.23	ASTM D1777
Compressive Strength: psf	6,000	ASTM D1621
Transmissivity; Gradient = 1.0, Normal Stress = 5000 psf, gpm/ft.	4.0	ASTM D4716
Note: (1) All numeric values represent minimum values.		

The geocomposite core shall be connected to outlet pipes or weep holes as shown on the plans. These fittings shall allow entry of water from the core, but shall not allow intrusion of backfill material into the core.

1014-6.02 Geocomposite Wall Drain Fabric:

The geocomposite wall drain fabric shall be laminated onto or adhere to the side of the drainage core which will face the backfill. Geocomposite wall drain fabric shall meet the requirements of Subsection 1014-9 of the specifications. A minimum 3-inch wide flap of fabric shall extend beyond both longitudinal edges of the geocomposite core. The fabric shall cover the full length of the core.

1014-7 Geocomposite Edge Drain System:

The geocomposite edge drain system shall be of composite construction, consisting of a supporting rectangular structure of drainage core material wrapped with a geotextile filter fabric. The fabric shall surround and be attached to the core material in a manner which does not restrict the flow capacity of the core material. The geocomposite edge drain system shall be resistant to commonly encountered chemicals and hydrocarbons, and resistant to ultraviolet exposure.

1014-7.01 Geocomposite Edge Drain Core:

The geocomposite edge drain core material shall consist of a preformed, stable, polymer plastic material with a cuspated, nippled, ridged, slotted, and/or perforated structure. The drainage core shall provide support for and may be bonded to the geotextile filter fabric. Its preformed structure shall be perforated to allow water to flow freely to the weep hole drainage outlets. If not perforated during manufacture, the core shall be perforated in the field at the weep hole drainage outlet locations unless otherwise approved by the Engineer. The core shall have at least

14 square inches of flat area in contact with the geotextile fabric to support the fabric per square foot. The core material shall additionally conform to the following physical requirements:

Geocomposite Edge Drain Core Requirements		
Property	**Requirement** (Note 1)	**Test Method**
Thickness Wrapped with Fabric: inch	0.75	ASTM D1777
Compressive Strength: psf	6,000	ASTM D1621
Transmissivity; Fabric Wrapped Core, Gradient = 0.1, Normal Stress = 1440 psf, gpm/ft.	4.0	ASTM D4716, (Note 2)
Width: ft.	1.0 (Note 3)	Measured

Notes:

(1) All values represent minimum values.

(2) Use a full width panel, if possible, testing flow on the side which may be placed against the soil to be drained.

(3) Minimum width normally required, but shall be the minimum width specified on the plans, if that is greater.

1014-7.02 Geocomposite Edge Drain Fabric:

The geocomposite edge drain fabric shall completely wrap around the drainage core material in a snug manner and may be permanently bonded to the core. Geocomposite edge drain fabric shall meet the requirements of Subsection 1014-9 of the specifications.

1014-7.03 Outlet Pipes:

The outlet pipe for the edge drain outlet lateral shall be rigid, 4-inch in diameter, Schedule 40 PVC pipe conforming to the requirements of ASTM D1785. The open end of the outlet pipe conduit shall be connected into either a drainage structure or a concrete pad drain in accordance with the details shown on the plans.

1014-8 Temporary Silt Fence Fabric:

Temporary silt fence fabric shall contain a stabilizer or inhibitors to make the filaments resistant to deterioration resulting from exposure to sunlight or heat.

The edges of the fabric shall be finished to prevent the outer yarn from pulling away from the fabric. The fabric shall be free of defects or flaws which significantly affect its physical or filtering properties. The fabric shall have a minimum width of 36 inches. Sheets of fabric may be bonded together. No deviation from any physical requirements will be permitted due to the presence of the seam.

The fabric may be manufactured with pockets for posts, hems with cord or with posts preattached using staples or button head nails.

During periods of shipment and storage, the fabric shall be wrapped in a heavy duty protective covering which will protect the cloth from sunlight, mud, dust, and debris.

The fabric shall not be exposed to temperatures greater than 160 degrees F.

Temporary silt fence fabric shall additionally meet the following requirements:

Temporary Silt Fence Requirements			
Property	**Supported Silt Fence** (Note 1)	**Unsupported Silt Fence** **Woven** **Elongation <50%** (Note 2)	**Test Method**
Maximum post spacing: ft.	8	6.5	-
Grab Strength: lb. MD (Note 3) and XMD (Note 4)	124	124	ASTM D4632
Permittivity: sec^{-1}	0.05		ASTM D4491
Apparent Opening Size: U.S. Standard sieve size	No. 30		ASTM D4751
Ultraviolet Stability (retained strength):	≥ 70% after 500 hours exposure		ASTM D4355

Notes:

(1) Silt fence support shall consist of 14-gauge steel wire with a maximum mesh spacing of 6 inches by 6 inches or prefabricated polymeric mesh with a minimum strength of 200 lb./ft. x 200 lb./ft. per ASTM D6637.

(2) As measured in accordance with ASTM D4632.

(3) MD: Machine direction which is along roll length.

(4) XMD: Cross machine direction which is across the roll width.

1014-9 Drainage Fabric:

Drainage fabric shall meet the following requirements:

Drainage Fabric Requirements		
Property	**Non-Woven** **Elongation ≥50%** (Note 1)	**Test Method**
Grab strength: lb.	157	ASTM D4632
Tear strength: lb.	56	ASTM D4533
Puncture strength: lb.	309	ASTM D6241
Ultraviolet stability (retained strength):	≥ 50% after 500 hours exposure	ASTM D4355
Permittivity: sec^{-1}	0.5	ASTM D4491
Apparent opening size: U.S. Standard sieve size	No. 70	ASTM D4751
Note: (1) As measured in accordance with ASTM D4632.		

1014-10 Stabilization Fabric:

Stabilization fabric shall meet the following requirements:

Stabilization Fabric Requirements		
Property	**Woven** **Elongation <50%** (Note 1)	**Test Method**
Grab strength: lb.	315	ASTM D4632
Tear strength: lb.	112	ASTM D4533
Puncture strength: lb.	618	ASTM D6241
Ultraviolet stability (retained strength):	≥ 50% after 500 hours exposure	ASTM D4355
Permittivity: sec^{-1}	0.05	ASTM D4491
Apparent opening size: U.S. Standard sieve size	No. 40	ASTM D4751
Note: (1) As measured in accordance with ASTM D4632.		

SECTION 1015 EPOXY RESIN ADHESIVES:

1015-1 General Requirements:

Certificates of Compliance, conforming to the requirements of Subsection 106.05 of the specifications, shall be submitted to the Engineer by the contractor for any epoxy resin adhesives used on a specific project. Only those epoxy resin adhesives shown on the Department's Approved Products List (APL), or equal, will be allowed for use. Approved products may only be used in accordance with the limitations stated in the manufacturer's instructions, the APL, and the International Code Council Evaluation Service (ICC-ES) evaluation report for the product, if applicable. Copies of the most current version

of the APL are available on the internet from the ADOT Research Center, through its Product Evaluation Program.

Epoxy resin adhesives shall be a two-component system that meets the requirements of ASTM C881, shall be furnished in the type, grade, and class specified, and shall meet all the requirements specified herein. For pre-packaged cartridge kits, the epoxy resin adhesive shall meet the requirements of ASTM C881 when mixed according to the manufacturer's instructions, utilizing the manufacturer's mixing nozzle. When a grade or class is not specified, an appropriate grade and class shall be selected for the particular application and approved by the Engineer. Epoxy resin adhesives for patching external concrete shall be gray in color.

All epoxy resin adhesives shall be resistant to the action of weathering, moisture, acids, alkalis, and other environmental factors.

The contractor shall submit product literature and Safety Data Sheets (SDS). The literature shall identify the recommended product use or applications for which it is intended, and the directions for use.

1015-1.01 Packaging, Labeling, and Storing:

Each component of epoxy resin adhesive shall be packaged in containers of size proportional to the amount of that component in the mix so that one container of each component is used in mixing one batch of epoxy resin adhesive.

The containers shall be of such design that all of the contents may be readily removed, and shall be well sealed to prevent leakage. The containers and labeling shall meet U.S. Department of Transportation Hazardous Material Shipping Regulations, and the containers shall be of a material, or lined with a material, of such character as to resist any action or breakdown by the components.

Each container shall be clearly labeled with the product type and identification code, component designation (A or B), manufacturer's name, date of manufacture, batch or lot number, all directions for use, and such warnings or precautions concerning the contents as may be required by State or Federal Laws and Regulations.

Epoxy resin adhesive shall be stored in accordance with the manufacturer's recommendations at all times. Attention is directed to the characteristic of some epoxy resin components to crystallize or thicken excessively prior to use when stored at temperatures below 35 degrees F. Any material which shows evidence of crystallization or a permanent increase in viscosity or settling of pigments which cannot be readily dispersed with a paddle shall not be used.

1015-1.02 Directions for Use:

Use of epoxy resin adhesives shall be in accordance with the manufacturer's recommendations unless otherwise specified by the Engineer. Use of epoxy resin adhesives shall be allowed for only those uses as shown on the ADOT Approved Products List.

At the time of mixing, the two components of the epoxy resin adhesive shall be at a temperature between 60 and 85 degrees F, unless otherwise specified or approved by the Engineer. Any heating of the epoxy resin components shall be done by application of indirect heat.

Immediately prior to mixing, each component shall be thoroughly mixed with a paddle, unless otherwise specified. Separate paddles shall be used to stir each component.

Immediately prior to use, the components of the epoxy resin adhesive shall be mixed together in the specified ratios according to the manufacturer's recommendations. When mixed, all epoxy resin adhesive shall have a uniform color without streaks. No solvent shall be added to any epoxy resin adhesive.

Surfaces on which the epoxy resin adhesive is to be placed shall be free of rust, paint, grease, asphalt and loose or otherwise deleterious materials. The surface shall be dry unless otherwise allowed according to the manufacturer's recommendations for use. Any overlay or inserted material which is to be bonded to the underlying surface shall be placed before thickening of the epoxy resin adhesive has begun.

When epoxy resin adhesive is used as a binder to make mortar, the components of the epoxy resin adhesive shall be thoroughly mixed together before the sand or fine aggregate is added. The type, gradation, and proportion of sand or fine aggregate added and mixed with the epoxy resin adhesive to make mortar shall be as specified or recommended by the manufacturer. The sand or fine aggregate moisture content shall not be more than 0.5 percent as determined in accordance with AASHTO T 265. All surfaces against which mortar is to be placed shall be primed with a coat of the epoxy resin adhesive just prior to placing the mortar.

1015-2 Anchoring Adhesives - Steel to Concrete:

Epoxy resin adhesive anchoring systems shall be used for bonding anchors and rebar dowels into hardened concrete or masonry. Applications shall be limited to horizontal and down hole orientations. Epoxy resin adhesives shall not be used in any overhead vertical application, or permanently sustained purely axial tension application.

The anchoring adhesive shall consist of a two component epoxy resin adhesive formula that is packaged in a dual-cylinder cartridge that can automatically combine the constituents in the proper proportions. Manual proportioning of the components shall not be used for anchoring

applications. The adhesive shall not be used beyond the expiration date shown on the packaging.

For horizontal applications where flow out of the anchoring hole is a problem, high viscosity or non-sag anchoring adhesives shall be used. Low and medium viscosity anchoring adhesives may be utilized in down holes which open upward. The product shall only be used for the application and limitations for which it was designed according to the manufacturer's product literature. Post-installed anchoring adhesives shall be installed in accordance with the manufacturer's printed installation instructions (MPII). Installation of adhesive anchors shall be performed by personnel trained to install adhesive anchors.

(A) Structural Applications:

Structural applications are defined as those requiring the anchoring adhesive system to develop a minimum tensile and shear strength resistance to an applied load. Post-installed anchoring adhesives shall have been tested in accordance with ICC-ES Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete (AC308), which incorporates the requirements found in ACI 355.4. A current ICC-ES evaluation report for the anchoring adhesive shall be submitted to the Engineer, who will review the conditions of use listed in the report before it is approved for use on a project. The conditions of use include limitations on base material temperature since higher temperatures affect adhesive bond tension and shear load strength. The anchoring adhesive shall only be used for the broad category (un-cracked concrete, cracked concrete, or masonry) for which it has been designated in the ICC-ES report.

Horizontal applications where a component of the applied load will be in sustained tension shall be installed by an individual who has a current ACI/CRSI Adhesive Anchor Installer Certification.

(B) Load Transfer Dowel and Tie-Bar Applications:

Applications for load transfer dowels and tie-bars are defined as those required to transfer load across joints in concrete slabs, walls and other concrete and masonry members. Epoxy resin adhesive shall meet the requirements of ASTM C881 Type IV. The anchors shall be installed, using the anchoring adhesive in the concrete or masonry member in strict accordance with the manufacturer's instructions. The anchoring adhesive shall only be used for the broad category (un-cracked concrete, cracked concrete, or masonry) for which it has been designated in the manufacturer's product literature.

1015-3 Concrete to Concrete Bonding Adhesives:

(A) General:

The grade of the epoxy resin adhesive system shall match the proposed use as identified in the product literature provided by the manufacturer. The product shall specifically be designed for this application according to the manufacturer's product literature. The pot life of the material shall be determined in accordance with AASHTO T 237, Part I.

(B) Hardened Concrete to Hardened Concrete

Epoxy resin base adhesive to be used for adhering or bonding hardened concrete to hardened concrete and other materials shall conform to the requirements of ASTM C881, Type I for non-load bearing applications and Type IV for load bearing applications.

(C) Hardened Concrete to Fresh Concrete

Epoxy resin base materials to be utilized for adhering or bonding freshly mixed concrete materials to hardened concrete, shall conform to the requirements of ASTM C881, Type II, for non-load bearing applications and Type V for load bearing applications.

1015-4 Epoxy Resin Adhesive for Mortar:

Epoxy resin adhesive to be used for binder in mortar, shall conform to the requirements of ASTM C881, Type I, for non-load bearing applications and Type IV for load bearing applications. The grade of the epoxy resin adhesive system shall match the proposed use as identified in the product literature provided by the manufacturer. The product shall specifically be designed for this application according to the manufacturer's product literature.

When epoxy resin adhesive is used as a binder to make mortar, the components of the epoxy resin adhesive shall be thoroughly mixed together before the sand or fine aggregate is added. The type, gradation, and proportion of sand or fine aggregate added and mixed with the epoxy resin adhesive to make mortar shall be as specified or recommended by the manufacturer. The sand or fine aggregate moisture content shall not be more than 0.5 percent as determined in accordance with AASHTO T 265. All surfaces against which mortar is to be placed shall be primed with a coat of the epoxy resin adhesive just prior to placing the mortar.

1015-5 Epoxy Resin Adhesive for Crack Repair:

Epoxy resin adhesive to be used for crack repair in concrete, shall be furnished as two components which shall be mixed together at or just before the point of injection.

The epoxy resin adhesive shall conform to the requirements of ASTM C881, Type I, for use in non-load bearing applications and Type IV for use in load bearing applications. The grade of the epoxy resin adhesive system shall normally be Grade 1, low viscosity. Grade 2, medium

viscosity epoxy adhesive systems may be used in larger width cracks. The product shall specifically be designed for this application according to the manufacturer's product literature.

Immediately prior to injection, usually at or near the injection tip, the two components shall be brought together as part of the injection process. The injection equipment and process utilized shall be in accordance with the manufacturer's recommendations. No solvents shall be utilized to thin the material.

SECTION 1016 PACKAGED DRY CONCRETE AND MORTAR MATERIALS:

1016-1 General Requirements:

Certificates of Compliance, conforming to the requirements of Subsection 106.05(B) of the specifications, shall be submitted to the Engineer by the contractor for any packaged dry concrete or mortar materials used on a specific project. The packaged dry concrete or mortar material must be on the current ADOT Approved Products List prior to submittal for use on the project, and must be approved for the application for which it is intended.

Packaged dry concrete and mortar materials shall be furnished premixed in a dry state including hydraulic cement, fine aggregate, coarse aggregate, and other ingredients as required for product performance. Only the addition of mix water shall be required at the site of the work. Aqueous solutions, emulsions, or dispersions may be included as components of the packaged materials. The manufacturer may specify that these liquids are to replace some or all the mixing water. If the material contains soluble chlorides or other ingredients in sufficient quantity to cause corrosion to steel reinforcements, the material will not be acceptable.

The contractor shall submit product literature and Material Safety Data Sheets (MSDS). The literature shall identify the recommended product use or application for which it is intended and the directions for use.

1016-1.01 Packaging, Labeling, and Storing:

The dry concrete or mortar material shall be packaged in suitable containers of such design that all of the contents may be readily removed, and shall be moisture resistant to prevent premature hydration of the hydraulic cement in the mixture. The containers and labeling shall meet the applicable U.S. Department of Transportation Material Shipping Regulations, and the containers shall be of a material, or lined with a material, of such character as to resist any action or breakdown by the components.

Each package or container shall be clearly labeled with the product name, type and identification code, manufacturer's name, date of manufacture, batch or lot number, and such warnings or precautions concerning the contents as may be required by State or Federal Laws and Regulations. Additional information shall be either marked on the package or attached to it. The additional information may include surface preparation requirements; mixing, placing and curing instructions; maximum amount of water to be used or maximum recommended consistency; recommended maximum usable working time "pot-life" and approximate consistency at the end of that time; and the allowable temperature range for preparation and placement of the material.

Packaged dry concrete or mortar materials shall be stored in accordance with the manufacturer's recommendations at all times. Attention is directed to the characteristic of hydraulic cement materials to hydrate in the presence of moisture. Any material which shows evidence of hydration or does not appear suitable shall not be used.

1016-1.02 Directions for Use:

Use of packaged dry concrete or mortar materials shall be in accordance with the manufacturer's recommendations unless otherwise specified or limited by the Engineer. Use of packaged dry concrete or mortar materials shall be allowed for only those uses as shown on the ADOT Approved Products List.

At the time of mixing, the packaged dry concrete or mortar materials shall be at a temperature within the range allowed according to the manufacturer's recommendations unless otherwise specified or approved by the Engineer. Any heating of the dry materials shall be done by application of indirect heat. The manufacturer may permit, in the package instructions, adjusting the mixing water temperature to achieve temperature limitations imposed for use of the dry concrete or mortar materials.

Immediately prior to use, the mixing apparatus shall be clean, prewetted, and drained, and essentially free of hardened concrete, mortar, and other foreign material that can be removed with a trowel or with a hammer, using reasonable force. Water shall be added to the dry concrete or mortar mix materials and the materials shall be thoroughly mixed to the desired consistency according to the manufacturer's recommendations. When thoroughly mixed, the concrete or mortar mixture shall have a uniform color. The amount of mixing water may be varied to achieve the desired consistency for the proposed use; however, the maximum recommended amount of mixing water shall not be exceeded.

Surfaces on which the concrete or mortar material is to be placed shall be free of rust, paint, oil, grease, asphalt and loose or otherwise deleterious materials. The surface of existing concrete shall be roughened to ensure a good bond and shall be cleaned thoroughly with

water, leaving existing concrete saturated, but free of standing water. An epoxy resin base adhesive may be required to bond the concrete or mortar material to the old concrete. Any overlay or inserted material which is to be bonded to the underlying surface shall be placed before the concrete patching material has begun to set.

The concrete or mortar materials may be drypacked, troweled, flowed, pumped or vibrated into place unless otherwise recommended by the manufacturer or specified herein. Use of an epoxy adhesive for bonding requires a dry surface unless otherwise recommended by the adhesive manufacturer. The method of placement depends on the application, but shall be in accordance with the manufacturer's recommendations.

1016-2 Packaged Dry High-Early Strength Concrete:

Packaged dry high-early strength concrete materials for use in building and repair jobs requiring a more rapid strength development, such as required for the earlier removal of forms, shall conform to the requirements of ASTM C387.

The compressive strength of packaged high-early strength concrete material at three days shall be a minimum of 2,500 pounds per square inch. The compressive strength at seven days shall be a minimum of 3,500 pounds per square inch.

When placing the mixed high-early strength concrete against existing concrete for repair or patching applications, an epoxy resin base adhesive meeting the requirements of Subsection 1015-3 of the specifications shall be applied to the surface of the existing concrete prior to placing the new concrete.

1016-3 Packaged Dry Normal Strength Concrete:

Packaged dry normal strength concrete materials for use in building and repair jobs where thicknesses exceed 2 inches, shall conform to the requirements of ASTM C387, normal weight concrete. Typical uses include building or repairing sidewalks, steps, footings, and for setting posts.

The compressive strength of packaged normal strength concrete material at seven days shall be a minimum of 2,500 pounds per square inch. The compressive strength at 28 days shall be a minimum of 3,500 pounds per square inch.

When placing the mixed normal strength concrete against existing concrete for repair or patching applications, an epoxy resin base adhesive meeting the requirements of Subsection 1015-3 of the specifications shall be applied to the surface of the existing concrete prior to placing the new concrete.

1016-4 Packaged Dry High Strength Mortar:

Packaged dry high strength mortar materials for use in work requiring thicknesses less than 2 inches shall conform to the requirements of ASTM C387. Typical uses include topping and patching. High-strength mortar is often referred to as "sand mix."

The compressive strength (mortar cubes) of packaged high strength mortar material at seven days shall be a minimum of 3,000 pounds per square inch. The compressive strength at 28 days shall be a minimum of 5,000 pounds per square.

When placing the mixed high strength mortar against existing concrete for repair or patching applications, an epoxy resin base adhesive meeting the requirements of Subsection 1015-3 of the specifications shall be applied to the surface of the existing concrete prior to placing the new mortar.

1016-5 Packaged Dry Rapid-Hardening Concrete:

Packaged dry rapid-hardening concrete materials for use in rapid repairs to hardened concrete shall conform to the requirements of ASTM C928.

The compressive strength of packaged rapid-hardening concrete material at three hours shall be a minimum of 500 pounds per square inch. The compressive strength at one day shall be a minimum of 2,000 pounds per square inch and at seven days the compressive strength shall not be less than 4,000 pounds per square inch. The strength at 28 days shall not be less than the strength at seven days.

Rapid-hardening concrete materials shall be tested in accordance with the slant shear requirements of ASTM C882 by placing the test sample against a dummy section of hardened Portland cement mortar. The slant shear test samples prepared in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at one day and 1,500 pounds per square inch at seven days.

The allowable length change of the rapid-hardening concrete material shall be determined in accordance with the requirements of ASTM C157, except as modified in ASTM C928, Sections 8.3 and 7.3. Based on the lengths of 3-inch prisms at three hours, the allowable length increase after 28 days in water shall be less than + 0.15 percent. The allowable length decrease in air after 28 days shall be less than - 0.15 percent.

The rapid-hardening concrete shall have a slump of 3 inches at 15 minutes after addition of the mixing liquid. When placing the mixed rapid-hardening concrete against existing concrete for repair or patching applications, no adhesive or other bonding system will be necessary unless required by the manufacturer.

1016-6 Packaged Dry Very Rapid-Hardening Concrete:

Packaged dry very rapid-hardening concrete materials for use in rapid repairs to hardened concrete shall conform to the requirements of ASTM C928.

The compressive strength of packaged very rapid-hardening concrete material at three hours shall be a minimum of 1,000 pounds per square inch. The compressive strength at one day shall be a minimum of 3,000 pounds per square inch and at seven days the compressive strength shall not be less than 4,000 pounds per square inch. The strength at 28 days shall not be less than the strength at seven days.

Very rapid-hardening concrete materials shall be tested in accordance with the slant shear requirements of ASTM C882 by placing the test sample against a dummy section of hardened Portland cement mortar. The slant shear test samples prepared in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at one day and 1,500 pounds per square inch at seven days.

The allowable length change of the very rapid-hardening concrete material shall be determined in accordance with the requirements of ASTM C157, except as modified in ASTM C928, Sections 8.3 and 7.3. Based on the lengths of 3-inch prisms at three hours, the allowable length increase after 28 days in water shall be less than + 0.15 percent. The allowable length decrease in air after 28 days shall be less than - 0.15 percent.

The very rapid-hardening concrete shall have a slump of 3 inches at five minutes after addition of the mixing liquid. When placing the mixed very rapid-hardening concrete against existing concrete for repair or patching applications, no adhesive or other bonding system will be necessary unless required by the manufacturer.

1016-7 Packaged Dry Rapid-Hardening Mortar:

Packaged dry rapid-hardening mortar materials for use in rapid repairs to hardened concrete shall conform to the requirements of ASTM C928.

The packaged dry rapid hardening mortar material shall conform to the same requirements for rapid hardening concrete listed in Subsection 1016-5 of the specifications except that the compressive strength shall be determined on mortar cubes, the length changes will be determined using 1-inch prisms, and the consistency at 15 minutes after mixing will be a mortar flow of 100 percent, minimum.

1016-8 Packaged Dry Very Rapid-Hardening Mortar:

Packaged dry very rapid-hardening mortar materials for use in rapid repairs to hardened concrete, shall conform to the requirements of ASTM C928.

The packaged dry very rapid hardening mortar material shall conform to the same requirements for very rapid hardening concrete listed in Subsection 1016-6 of the specifications except that the compressive strength shall be determined on mortar cubes, the length changes will be determined using 1-inch prisms, and the consistency at five minutes after mixing will be a mortar flow of 100 percent, minimum.

SECTION 1017 NONSHRINK GROUT MATERIALS:

1017-1 General Requirements:

Certificates of Compliance, conforming to the requirements of Subsection 106.05 of the specifications, shall be submitted to the Engineer by the contractor for any nonshrink grout materials used on a specific project. Only nonshrink materials shown on the Department's Approved Products List (APL) will be allowed for use. Copies of the most current version of the APL are available on the internet from the ADOT Research Center, through its Product Evaluation Program. The nonshrink grout material must be approved for the use or application for which it is intended and shall meet the requirements of ASTM C1107, unless otherwise specified herein.

The contractor shall submit product literature and Material Safety Data Sheets (MSDS). The literature shall identify the recommended product use or application for which it is intended, and the direction for use.

Nonshrink grout materials shall be furnished premixed in a dry state including hydraulic cement, fine aggregate, and other ingredients as required for grout performance. Only the addition of mix water shall be required at the site of the work. Aqueous solutions, emulsions, or dispersions may be included as components of the packaged materials. The manufacturer may specify that these liquids are to replace some or all the mixing water. If the material contains soluble chlorides or other ingredients in sufficient quantity to cause corrosion to steel reinforcements, the material will not be acceptable.

1017-2 Packaging, Labeling, and Storing:

The nonshrink grout materials shall be packaged in suitable containers of such design that all of the contents may be readily removed, and shall be moisture resistant to prevent premature hydration of the hydraulic cement in the grout mixture. The containers and labeling shall meet the applicable U.S. Department of Transportation Material Shipping Regulations, and the containers shall be of a material, or lined with a material, of such character as to resist any action or breakdown by the components.

Each package or container shall be clearly labeled with the product name, type and identification code, manufacturer's name, date of manufacture, batch or lot number, and such warnings or precautions

concerning the contents as may be required by State or Federal Laws and Regulations. Additional information shall be either marked on the package or attached to it. The additional information may include surface preparation requirements; mixing, placing and curing instructions; maximum amount of water to be used or maximum recommended consistency; unit weight and yield at maximum recommended water content or maximum consistency; recommended maximum usable working time, also called "pot-life," and approximate consistency at the end of that time; and the allowable temperature range for preparation and placement of the material.

Nonshrink grout materials shall be stored in accordance with the manufacturer's recommendations at all times. Attention is directed to the characteristic of hydraulic cement materials to hydrate in the presence of moisture. Any material which shows evidence of hydration or does not appear suitable shall not be used.

1017-3 Directions for Use:

Use of nonshrink grout materials shall be in accordance with the manufacturer's recommendations unless otherwise specified or limited by the Engineer. Use of nonshrink grout materials shall be allowed for only those uses as shown on the ADOT Approved Products List.

At the time of mixing, the nonshrink grout materials shall be at a temperature within the range allowed according to the manufacturer's recommendations unless otherwise specified or approved by the Engineer. Any heating of the dry materials shall be done by application of indirect heat. The manufacturer may permit, in the package instructions, adjusting the mixing water temperature to achieve temperature limitations imposed for use of the grout materials.

Immediately prior to use, the grout mixing apparatus shall be clean, prewetted, and drained, and essentially free of hardened grout and other foreign material that can be removed with a trowel or with a hammer, using reasonable effort. Water shall be added to the grout materials and the grout shall be thoroughly mixed to the desired consistency according to the manufacturer's recommendations. When thoroughly mixed, the nonshrink grout mixture shall have a uniform color. The amount of mixing water may be varied to achieve the desired consistency for the proposed use; however, the maximum recommended amount of mixing water shall not be exceeded.

Surfaces on which the nonshrink grout material is to be placed shall be free of rust, paint, oil, grease, asphalt and loose or otherwise deleterious materials. The surface of existing concrete shall be roughened to ensure a good bond and shall be cleaned thoroughly with water, leaving existing concrete saturated, but free of standing water. Any overlay or inserted material which is to be bonded to the underlying surface shall be placed before the nonshrink grout material has begun to set.

The nonshrink grout materials may be drypacked, troweled, flowed, pumped or vibrated into place unless otherwise recommended by the manufacturer. The method of placement depends on the application, but shall be in accordance with the manufacturer's recommendations.

1017-4 Nonshrink Grout Material Requirements:

Nonshrink grout materials placed against existing concrete shall be tested in accordance with the slant shear requirements of ASTM C882 by placing nonshrink grout against a dummy section of hardened Portland cement mortar. The slant shear test samples prepared in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at seven days and 1,500 pounds per square inch at 28 days.

The Vicat time of set for the material shall be determined in accordance with AASHTO T 131. The time of set shall be within 25 percent or 10 minutes of the time of set specified by the manufacturer, whichever is greater. The time of final setting shall be a maximum of eight hours.

Nonshrink grout materials shall conform to the requirements of ASTM C1107. The compressive strength shall be determined in accordance with the requirements of ASTM C109.