

ARIZONA  
DEPARTMENT OF TRANSPORTATION

# STANDARD SPECIFICATIONS

for

ROAD AND BRIDGE  
CONSTRUCTION



2008

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DEPARTMENT OF TRANSPORTATION

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SPECIFICATIONS**

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CONSTRUCTION**

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Copies of the Standard Specifications for Road and Bridge Construction may be purchased by contacting:

Arizona Department of Transportation  
Engineering Records  
1655 W. Jackson, Room 112F  
Phoenix, AZ 85007  
Telephone (602) 712-7498

## INTRODUCTORY

Revision marks, vertical lines in the right margin, have been added to these Specifications to highlight areas where changes have occurred since the 2000 edition. Revision marks appearing in the space between two paragraphs are indicative of a deletion of a paragraph from the 2000 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."

In the contract, 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
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
AIA	American Institute of Architects
AIEE	American Institute of Electrical Engineers



## SECTION 101

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
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 Preservers' Association

AWPI	American Wood Preservers' Institute
AWS	American Welding Society
AWWA	American Water Works Association
AZI	American Zinc Institute
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
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
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineer's Association
ITE	Institute of Transportation Engineers
MAG	Maricopa Association of Governments
MUTCD	Manual on Uniform Traffic Control Devices

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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
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NIST	National Institute for Standards and Technology (U.S. Department of Commerce)
NLMA	National Lumber Manufacturer's Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration/Act
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PLP	Plastic Laminate Producers
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	Steel Structures Painting Council
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:

### **Acceptance:**

Activities performed by the Department, or its designated representative, to determine the quality and acceptability of the materials and workmanship incorporated in a project.

### **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:**

## SECTION 101

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.

### **Bidding Schedule:**

The prepared schedule, included as a part of the proposal pamphlet, 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 twenty-four hour period, and ending at midnight.

**Channel:**

A natural or artificial watercourse.

**Characteristic:**

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

**City, County, Township, or Town:**

A subdivision of the State used to designate or identify the location of the proposed work.

**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.

## SECTION 101

### **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 (Performance Bond and Payment Bond):**

The approved forms of security, furnished by the contractor and the contractor's surety or sureties, guaranteeing the full and complete performance of the contract and all supplemental agreements and the payment of all legal debts pertaining to the construction of the project.

### **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.
- (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.



## SECTION 101

### **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.

### **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 vehicular travel, including the entire area within the right-of-way.

### **Holidays:**

Those days defined as legal holidays in Arizona Revised Statutes, 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.

### **Item (Pay Item):**

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

### **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.

<b>When the original total contract dollar amount is:</b>		<b>A major item shall be equal to or greater than the following amount: (in dollars)</b>
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
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.

## SECTION 101

### **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."

### **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 for purchase from:

Records Administration Section  
Engineering Records  
Arizona Department of Transportation  
1655 West Jackson, Room 112F  
Phoenix, Arizona 85007 (602) 712-7498

**(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.

## SECTION 101

### **Proposal Form:**

The prescribed form on which the bidder's offer is submitted.

### **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:**

See 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 within top and side slopes, 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:**

Items 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; and 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.

## SECTION 101

### **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:

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

Where: s = standard deviation  
x<sub>i</sub> = individual value  
AVE = average value  
n = number of values

### **State:**

The State of Arizona, acting through its authorized representatives in the Arizona Department of Transportation.

### **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.



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### **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, on which weather and other conditions not under the control of the contractor permit construction operations to proceed for the major part of the day with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time.

## **SECTION 102 BIDDING REQUIREMENTS AND CONDITIONS:**

### **102.01 Advertisements for Bids:**

The advertisement for bids may contain the following information:

- Project number and name of highway,
- Route number and mileposts or reference markers.
- Date, time and place of public opening of bids,
- Location and length of project,
- General description of work, principal items and approximate quantities,
- Specified contract time (working days, calendar days or fixed dates) for completion of contract work,
- Statement of proposal requirements,
- Manner in which project plans and specifications may be obtained and the cost of same.
- Type and amount of proposal guaranty.

### **102.02 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.

### **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; or
- (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.

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                      Contents of Proposal Pamphlet:**

Upon request, the Department will furnish the prospective bidder a proposal pamphlet. This pamphlet will state the location and description of the contemplated construction and will show the approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished and will have a schedule of items for which unit bid prices are invited. The proposal pamphlet will state the time in which the work must be completed, the type and amount of the proposal guaranty and the date, time and place of the opening of proposals. The pamphlet will also include any Special Provisions or requirements which vary from or are not included in the Standard Specifications. Additional contract documents applicable to the specific project are listed in the Special Provisions.

All papers bound with or attached to the proposal pamphlet are considered a part thereof. The project plans, specifications, Standard Drawings and other documents designated in the proposal pamphlet, will be considered a part of the proposal whether attached or not.

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The project plans and proposal pamphlets are available at the price per set indicated in the advertisement for bids.

### **102.05 Issuance of Proposals:**

The Department reserves the right to refuse to issue a proposal pamphlet 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.
- (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 former contracts in force at the time of issuance of a proposal pamphlet.
- (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.

#### **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.

A set of plans, earthwork calculations and plotted cross sections and other material, if available, will be on file with Contracts and Specifications, 1651 W. Jackson, Room 121F, Phoenix, for contractors to review in the process of preparing bids for projects containing earthwork. A copy of the calculations and cross-sections may also be purchased for a nominal fee, but must be requested not less than five working days in advance of the bid opening.

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 Engineer. The Engineer 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 as an addendum to the Proposal Form, and will be furnished 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 award of the contract by Department employees or agents are not binding.

#### **102.08 Preparation of Proposal:**

##### **(A) General:**

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The bidder shall prepare and submit its proposal on either the paper forms furnished by the Department in the proposal pamphlet or, when electronic bidding is available, using Department-furnished bid preparation software.

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

The bidder shall submit its proposal exclusively on either the paper proposal pamphlet forms or using the electronic bid process described herein.

When an item in the proposal contains a choice to be made by the bidder, the bidder shall indicate a choice in accordance with the specifications for that particular item and after the bid opening no further choice will be permitted.

### **(B) Proposal Pamphlet Paper Submittal:**

Proposals submitted using the paper format shall be only upon the forms furnished by the Department. No consideration will be given to any purported proposals on other forms, or to any request to modify or change a proposal.

The bidder shall complete and fully execute all required forms listed under "Bid Submission" in the special provisions. Proposal pamphlets are not transferable.

The bidder shall specify a unit price, in figures, for each pay item for which a quantity is given in the Bidding Schedule and shall also show the amount extended, as the product of the quantity given and the unit price indicated for each bid item, in the column provided for that purpose. The total amount of the bid shall be obtained by adding the amounts of the several items.

In the event that more than two decimal places are used in representing a unit price, all digits beyond the second decimal place will be truncated and the extended amount for the affected item(s) and the total bid will be recomputed accordingly.

An individual bidder shall clearly show his/her name, post office address and signature.

A general partnership bidder shall clearly show the name and post office address of each member of the partnership and the signature of one or more members of the partnership.

A limited partnership bidder shall clearly show the name and post office address of each member of the partnership and the signature of one or more general partners.

A joint venture bidder shall clearly show the name and post office address of each member or officer of the firms and the signature of one

or more members or officers of each firm represented by the joint venture.

A corporate bidder shall clearly show the names, titles and business addresses of the president, vice president, secretary and treasurer; the name of the corporation; the state in which the corporation was incorporated; and the signatures of one or more officers of the corporation or by a legally qualified agent of the corporation acceptable to the Department. Evidence of authority of the signing officer(s) to submit a proposal on behalf of the corporation shall either be attached thereto or be on file with the Department. If the corporation is incorporated in any state other than the State of Arizona, the corporation shall submit to the Department, prior to the award of contract, proof from the Arizona Corporation Commission that it has been granted authority to do business in the State of Arizona.

**(C) Electronic Submittal:**

**(1) General:**

Projects eligible for electronic bidding will be identified in the Advertisement for Bids. Eligible projects can also be identified on ADOT's website at [www.azdot.gov/highways/cns/phone\\_sheet.asp](http://www.azdot.gov/highways/cns/phone_sheet.asp). Projects with electronic files available (EBS files) will be highlighted.

In order to submit a bid electronically, a firm must have obtained a bidder identification number from the Department, at the office of Contracts and Specifications, 1651 W. Jackson Street, Room 121F, Phoenix, AZ 85007, phone (602) 712-7221.

In addition, bidders must subscribe to Bid Express, an online bidding service, and obtain a digital signature. Bid Express can be reached at [www.bidx.com](http://www.bidx.com), phone (352) 381-4888. The bidder shall also download and install a copy of the AASHTO "Trns-Port Expedite" bid software from the internet at the Bid Express website by selecting "Arizona" from the map displayed on the Bid Express homepage. The version of the software currently used by ADOT can then be located by selecting the "utilities" tab and choosing the "Expedite" utility.

In order to obtain a digital signature, bidders shall be required to name at least one responsible person who shall be authorized 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 EBS file, listed as an Expedite Data File on the Bid Express website. The file includes a schedule of items folder containing the bid schedule, and a miscellaneous folder containing the proposal and attachments. The bidder shall review the proposal and complete the bidding schedule, as specified herein, and the attachments.

The bidder shall specify a unit price for each pay item for which a quantity is given in the bidding schedule. The software will

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automatically produce the extended amount, as the product of the quantity given and the specified unit price. Unit prices shall be stated in whole cents.

The bidder shall also download all addenda issued and update the project file accordingly. The bidder shall be responsible to verify that all addenda issued prior to the bid opening have been included in its submittal.

The bidder shall be responsible for the successful submission of its electronic bid prior to the time specified for submission of bids. Bids submitted after the specified time will not be accepted. 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 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.

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

If necessary, Bid Express will attempt to retrieve a copy of the encrypted bid from the bidder's computer.

The Department will authorize Bid Express to send the Department a program which will enable the encrypted bid to be opened and processed.

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 award the contract to the bidder submitting the missing bid if appropriate. The Department will notify all bidders.

### **102.09 Non-Collusion Certification:**

Bidders making their submittal using paper forms in the Proposal Pamphlet shall complete the Non-Collusion Certificate included with the proposal form. This form shall be executed by or on behalf of the person, firm, association or corporation submitting the bid, in the following form:

The bidder certifies that, pursuant to Subsection 112(c) of Title 23, United States Code and Title 44, Chapter 10, Article 1 of the Arizona Revised Statutes, 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 full competitive bidding in connection with the above referenced project.

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

#### **102.10 Irregular Proposals:**

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

- (1) If any of the proposal documents show unauthorized alterations of any kind.
- (2) If the proposal contains conditional or uncalled-for alternate bids.
- (3) If the proposal documents contain erasures not initialed by the person or persons signing the proposal.
- (4) If there is a submission of any kind which may tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.
- (5) If the bid is mathematically unbalanced.
- (6) If the bid is materially unbalanced.
- (7) If the bidder fails to sign the non-collusion certificate when submitting a bid in the paper format.

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

- (1) If the proposal, bid bond or bidding schedule is on a form other than that furnished by the Department.
- (2) If the bidder or surety fails to provide a proposal guaranty as specified in Subsection 102.12.
- (3) If the bidder fails to sign the proposal when submitting a bid in the paper format.



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- (4) If the bidding schedule does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.
- (5) 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.
- (6) If the bidder submits a proposal in both the electronic format and in the paper format.

### **102.11            Delivery of Proposals:**

For submittals made in accordance with 102.08(B), each proposal, together with the required proposal guaranty, shall be placed in the special envelope furnished by the Department for this purpose and the envelope shall be sealed. All proposals shall be submitted prior to the time specified for submission of bids and at the place specified in the advertisement for bids. Proposals received after the time set for opening the bids will be returned to the bidder unopened.

Electronic submittals shall be made in accordance with Subsection 102.08(C).

### **102.12            Proposal Guaranty:**

#### **(A)            General:**

The bidder shall provide a 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 submitting paper proposals in accordance with Subsection 102.08(B) shall provide a proposal guaranty as specified in 102.12(B), and shall include the guaranty with the proposal at the time of submittal.

Bidders submitting proposals electronically in accordance with Subsection 102.08(C) shall provide either a paper proposal guaranty in accordance with Subsection 102.12(B) or an electronic proposal guaranty in accordance with Subsection 102.12(C).

If the bidder elects to submit the guaranty in paper format, it shall be submitted prior to the time specified for submission of bids. The paper guaranty shall be placed in the special envelope furnished by the Department for submittal of bids, and shall be sealed. The bidder shall write "Proposal Guaranty Only" on the envelope. If the bidder elects to

submit the guaranty in electronic format, it shall be included as part of the proposal at the time of the submittal.

**(B) Paper Submittal of Proposal Guaranty:**

The paper proposal guaranty shall be in the form of either a certified or a cashier's check made payable to the Arizona Department of Transportation for 10 percent of the amount of the bid, or in the form of a surety (bid) bond for 10 percent of the amount of the bid.

The surety (bid) bond will be accepted only on the form provided by the Department.

The surety shall provide a current Power of Attorney attached to the surety bond.

Paper proposal guarantees shall be delivered to the Department, at the Office of Contracts and Specifications, 1651 W. Jackson Street, Room 121F, Phoenix, AZ, phone (602) 712-7221.

**(C) Electronic Submittal of Proposal Guaranty:**

Two companies have established web-based surety processing procedures with Bid Express: Surety 2000 ([www.surety2000.com](http://www.surety2000.com)) and Sure Path Network ([www.insurevision.com](http://www.insurevision.com)). Bidders interested in providing an electronic proposal guaranty may contact these companies for additional information and requirements.

**102.13 Withdrawal of Proposals:**

**(A) General:**

The bidder may withdraw its bid prior to the time scheduled for submission of bids.

For paper submittals made in accordance with Subsection 102.08(B), a bidder may withdraw its proposal unopened after it has been submitted to the Department, provided its request in writing is received by the Department prior to the time specified for submission of bids.

For electronic submittals, in accordance with Subsection 102.08(C), a bidder may withdraw its submittal at any time prior to the time specified for submission of bids, provided that the bidder withdraws such bid electronically.

**(B) Conditional Withdrawal:**

When proposals for more than one contract are to be publicly read on any one date, a bidder may request that, in the event it is the apparent low bidder on a given contract or contracts, one or more subsequent bids are withdrawn.

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The bidder shall submit a written request for conditional withdrawal, separate from the proposal submittals and signed by a responsible person, prior to the time specified for submission of bids. Bids withdrawn will be retained by the Department and will not be read.

No requests for conditional withdrawals will be accepted after the time specified for submission of bids.

### **102.14 Combination or Conditional Proposals:**

If the Department so elects, proposals may be issued for projects in combination or separately so that bids may be submitted either on the combination or on separate units of combination. The Department reserves the right to make awards on combination bids or separate bids to the best advantage of the Department. No combination bids, other than those specifically set up in the proposal by the Department, will be considered.

Conditional proposals will be considered when so stated in the Special Provisions.

### **102.15 Public Opening of Proposals:**

Proposals will be opened and read aloud at the time and place indicated in the advertisement for bids. Bidders, their authorized agents and other interested parties are invited to be present.

### **102.16 Licensing:**

It is the responsibility of the bidder to determine whether it has the appropriate contracting licenses to perform the work. The Department will make the award, if any, to the lowest responsible bidder who has the proper licenses. For all projects except Federal-aid funded projects, the bidder must have the proper licenses at the time the bid is submitted to the Department. 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 before award can be made, and no later than 60 days after the date bids are opened. Licensing information is available from the Arizona Registrar of Contractors.

## **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 Arizona Revised Statutes 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;
- (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 labor and material on former contracts in force at the time of issuance of a proposal pamphlet;
- (E) Failure to comply with any qualification regulations of the Department;
- (F) Default under previous contracts;

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- (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 Return of Proposal Guaranty:**

Proposal guaranties will be returned immediately following the opening and checking of proposals, except that of the lowest qualified bidder; however, the Department at its discretion, may also retain the proposal guaranty of the second lowest qualified bidder.

Proposal guaranties that have been retained will be returned promptly upon completion of both of the following actions:

Execution of the contract.

The execution and filing with the Department of satisfactory bonds and contract forms.

### **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.
- (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 Arizona Revised Statute, 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 contractor shall return the signed contract and bonds so as to be received by the Department no later than 10 calendar days after the date of the notice of award letter.

Contracts and bonds should be addressed as follows:

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Arizona Department of Transportation  
Contracts and Specifications Services  
1651 West Jackson Street, Room 121F  
Phoenix, Arizona 85007

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 the parties.

### **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 shall be just cause for 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.

### **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 must 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, 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



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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 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. 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.

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.
- (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; or
  - (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.

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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.

### **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 for 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. In addition to proceeding in accordance with Subsection 104.02, 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; and
  - (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.

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.

**(C) Maintenance Directed by the Engineer:**

The Engineer may determine that work is required to insure 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. 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 provided, 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.

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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 Arizona Revised Statutes Section 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 Landscape Defacement; Protection of Streams, Lakes and Reservoirs:**

The contractor shall give special attention to the effect of its operations upon the landscape and shall take special care to maintain natural surroundings undamaged.

The contractor shall take sufficient precautions, considering various conditions, to prevent pollution of streams, lakes, and reservoirs with fuels, oil, bitumens, calcium chloride, fresh Portland cement, fresh

Portland cement concrete, raw sewage, muddy water, chemicals or other harmful materials. None of these materials shall be discharged into any channels leading to such streams, lakes or reservoirs.

Where the contractor's working area encroaches on a running or an intermittent stream, barriers shall be constructed and maintained between the working areas and the stream or stream bed adequate to prevent the discharge of any contaminants into the stream or stream bed.

Frequent fording of running streams with construction equipment will not be permitted; therefore, temporary bridges or other structures shall be used whenever an appreciable number of crossings is necessary.

Unless approved in writing by the Engineer, mechanical equipment shall not be operated in running streams.

Streams, lakes and reservoirs shall be promptly cleared of all falsework, piling, debris or other obstructions placed thereby or resulting from construction operations.

At the time of the preconstruction conference, the contractor shall submit, for the Engineer's approval, a program which includes all the measures which the contractor proposes to take for the construction of permanent erosion control work specified in the contract and all the temporary control measures to prevent erosion and pollution of streams, lakes and reservoirs.

Permanent erosion control work and pollution prevention measures shall be performed at the earliest practicable time consistent with good construction practices. Temporary work and 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 program 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. Unless otherwise permitted by the Engineer, the contractor shall not expose an area of erodible earth material greater than 750,000 square feet at any one location.

The Engineer may order the contractor to provide immediate measures to control erosion and prevent pollution. Such measures may involve the construction of temporary berms, dikes, dams, sediment basins and

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slope drains; the use of temporary mulches, mats and seeds and the use of other devices, methods, items, etc., as necessary.

At any time the contractor proposes to change its schedule of operations, the contractor shall review and update its erosion and pollution control program 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 erosion and pollution control program.

Erosion control and pollution prevention work specified in the contract which is to be accomplished under any of the various contract items will be paid for as specified under those items.

The cost of any erosion control and pollution prevention work which may be proposed by the contractor in its program, 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 stormwater management plan for submission to the Engineer outlining the procedures the contractor proposes to use in the control and disposal of storm water 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 within 15 calendar days after the preconstruction conference.

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.

Except as specifically provided under Subsection 104.04(B), 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. During such period of suspension of work, the contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedlings and soddings, furnished under its contract and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

**104.11 Damage by Storm, Flood or Earthquake:**

Attention is directed to Subsection 104.10, 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

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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).

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, 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.

### **(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, "Adjustments in the Contract Price." 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.

### **(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, "Termination of Contract for Convenience of the Department."

## **104.12 Environmental Analysis:**

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

- (A) If the contractor elects to provide material from a contractor-furnished source,
- (B) If the contractor elects to utilize any site, to set up a plant for the crushing and processing of base and surfacing materials, or processing base, surfacing, or concrete

materials which is not located on a site furnished by the Department or the site of a commercial operation, or

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

The contractor shall promptly advise the Engineer that it is preparing the analysis and shall submit it upon completion. The contractor should anticipate needing a minimum of 30 days to coordinate with the necessary jurisdictions or agencies and to prepare the analysis. The analysis will be reviewed by the Department and the contractor will be advised whether or not the analysis is acceptable as soon as the necessary determinations have been made. The contractor shall allow 14 days for the Department's review.

If the preparation, and approval of the environmental analysis causes a delay to a controlling activity of the project, the contractor may seek, and the Engineer may grant, an extension of time for the preparation of the analysis in accordance with the terms of Subsection 108.08. The time extension shall not exceed 30 working days.

An environmental analysis shall address itself to 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 with acknowledged credentials, which credentials shall be attached to the survey. The survey



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shall be prepared in a State Historic Preservation Office standardized format. The survey shall identify cultural resources within the potential impact area of the materials source processing area, and haul road. Additionally the survey report shall identify historic or archaeological sites in the vicinity.

- (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 and mitigation of such effects on access, public facilities and adjacent properties.
- (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 and/or nearby water bodies shall be addressed. Measures to mitigate potential water quality impacts shall be coordinated through the Arizona Department of Environmental Quality.
- (O) A description of the impact on endangered or threatened wildlife and plants and their habitat. The analysis of potential impact to plants and wildlife shall be coordinated through the Arizona Game and Fish Department and US Fish and Wildlife Service. 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 and/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.

Guidance in preparing the environmental analysis is available from ADOT's Environmental Planning Section, 205 South 17th Avenue, Room 240E, Phoenix, AZ 85007, phone (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 equally between the contractor and the Department as specified in Subsection 104.13(D).

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

**(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).
- (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.

**(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.
- (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), 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 50 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, such as a Metrotech Model 810 or approved equal. 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, or for landscape irrigation lines smaller than two inches in diameter. For Salt River Project 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 High Density Polyethylene (HDPE) and Vitrified Clay Pipe (VCP); and for Polyvinyl Chloride pipe (PVC) two 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) and (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 a minimum 12 American Wire Gauge (AWG) solid copper. 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 (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.



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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.

## **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

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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 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. 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 which are drawings or prints shall be 36 by 22 inches in size. There shall be a two-inch margin on the left side of the 36-inch dimension and a 1/2-inch margin on the remaining three sides. A blank space, four inches wide by three 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.

Five sets of prints or other acceptable copies and one set of positive reproduces, such as positive mylars or positive sepia, shall be submitted to the Engineer for review. The prints and the reproduces shall be clear, precise and suitable for microfilm photography. Upon completion of the review, the Engineer will stamp the drawings in accordance with item A, B, or C listed above and return one set of the prints to the contractor. Drawings requiring a resubmittal shall be

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revised in accordance with the Engineer's annotations, after being verified by the contractor, and resubmitted as described above, including the set of positive reproducibles. 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:**

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

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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.

### **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.

#### **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



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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.

### **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. 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.

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.

## SECTION 105

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 Motor Vehicle Division, Arizona Department of Transportation. 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).

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, 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. 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.

**105.19 Substantial Completion:**

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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 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 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.

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

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- (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).

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) Contractor's Options After State Engineer Review: 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 \$200,000.00 or less, the contractor's sole legal remedy shall be arbitration as prescribed in Subsection 105.22.
- (2) Where the amount in controversy is more than \$200,000.00, the contractor's sole remedy shall be to initiate litigation pursuant to Section 12-821 et seq. of the Arizona Revised Statutes.

(E) Mediation: 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 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 Section 12-1512, Arizona Revised Statutes. 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 \$200,000.00 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 these specifications.

Any contractor having a claim, adjustment or dispute for an amount in excess of \$200,000.00 may waive or abandon the dollar amount of any such claim in excess of \$200,000.00 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 \$200,000.00. Various damages claimed by the contractor for a single claim may not be divided into separate proceedings to create claims within the \$200,000.00 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.

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.

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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.

Sampling and testing of materials shall be in accordance with the requirements of:

- The ADOT Materials Testing Manual
- The ADOT Materials Policy and Procedure Directives Manual.
- Applicable Federal, AASHTO, or ASTM specifications or test designations.
- Applicable specifications or test designations of other nationally recognized organizations.

Whenever a reference is made to an Arizona Test Method or an ADOT Materials Policy and Procedure Directive, it shall mean the test method or policy and procedure directive in effect on the bid opening date.

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). 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). Specific contractor quality control requirements will be shown in the applicable construction items. Payment for such additional work shall be in accordance with the Special Provisions, and shall be included in Bidding Schedule Item 9240170.

**(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 ADOT System for the Evaluation of Testing Laboratories. Approved laboratories, and the test methods for which they are approved to perform, are listed in the ADOT Directory of Approved Materials Testing Laboratories. Approved test methods listed in the ADOT Directory of Approved Materials Testing Laboratories do not include field sampling and testing procedures. When field sampling and testing procedures

are performed, the appropriate valid Arizona Technical Testing Institute (ATTI) and/or American Concrete Institute (ACI) certification(s) are required. The ADOT System for the Evaluation of Testing Laboratories and the ADOT Directory of Approved Materials Testing Laboratories may be obtained from ADOT Materials Group, Quality Assurance Section, 1221 North 21st Avenue, Phoenix, Arizona 85009.

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
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.

**TABLE 106-1 CONTINUED****QUALITY SAMPLING AND TESTING SUPERVISOR REQUIREMENTS**

- (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.

<b>TABLE 106-2</b>	
<b>QUALITY SAMPLING AND TESTING TECHNICIAN REQUIREMENTS</b>	
<b>Soils and Aggregate</b>	
<b>Field</b>	<b>Laboratory</b>
Arizona Technical Testing Institute (ATTI) "Field" certification.	Arizona Technical Testing Institute (ATTI) "Laboratory Soils/Aggregate" certification.
<b>Asphaltic Concrete</b>	
<b>Field</b>	<b>Laboratory</b>
Arizona Technical Testing Institute (ATTI) "Field" certification.	Arizona Technical Testing Institute (ATTI) "Asphalt" Certification.
<b>Concrete</b>	
<b>Field</b>	<b>Laboratory</b>
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 state the types of work, such as earthwork, Portland cement concrete, or asphaltic concrete, which have been performed during the report period, and shall also include the process control measures taken to assure quality. The weekly report shall provide sample identification information for materials tested during the report period, including sample number, date sampled, sample location, person obtaining 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. Although hand-written documentation can be included, the quality control report narrative, sample identification information,

results for tests and any retests, and corrective actions shall be typed to ensure the Department can make clear reproductions of the documents.

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.

Reports not submitted by the above-referenced deadline shall be considered delinquent, and monies shall be deducted from the contractor's monthly estimate in accordance with the requirements of Subsection 3.2 of Item 9240170 – CONTRACTOR QUALITY CONTROL.

#### **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 these specifications or the Special Provisions require that such a certificate be furnished.

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 shall comply with the requirements specified herein and of the Materials Testing Manual.

##### **(B)        Certificate of Compliance:**

A Certificate of Compliance shall contain the following information:

- (1) A description of the material supplied.
- (2) Quantity of material represented by the certificate.
- (3) Means of material identification, such as label, lot number, or marking.
- (4) 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 194, ASTM A 588; or specific table or section of the Arizona Department of Transportation Standard Specifications or Special Provisions. Certificates may cite both, if applicable.



## SECTION 106

- (5) The name, title, and signature of a person having legal authority to bind the manufacturer or the supplier of the material. The date of the signature shall also be given. The name and address of the manufacturer or supplier of the material shall be shown on the certificate. A copy or facsimile reproduction will be acceptable. However, the original certificate shall be made available upon request. The person signing the certificate shall be in one of the following categories:

- (a) An officer of a corporation.
- (b) A partner in a business partnership or an owner.
- (c) A general manager.
- (d) Any person having been given the authority in writing by one of the three listed above. The manufacturer or supplier may submit a list of those who are authorized to sign certificates. This list shall be submitted under the name, title, and signature of one of the first three listed above. This list will be kept on file for subsequent certificates received on that project.

Each of the first four items specified above shall be completed prior to the signing as defined in item five. 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.

### **(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 for Value Engineering Proposals.

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- (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 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 quantities of materials as loaded and intended for incorporation into the work and the quantities 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 Arizona Transportation Research Center (ATRC), through its PRIDE 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

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the requirements of the plans and specifications, and are submitted for approval as specified below:

- (A) No consideration will be given to a request for approval of a new product prior to contract award. After award and in time to permit consideration and testing without delaying work, the contractor shall submit a written request for approval.
- (B) A request for approval shall include all information necessary for proof of conformance to the requirements of the plans and specifications, including samples for testing, if required.
- (C) The Department will evaluate the information submitted and perform tests when necessary. The Engineer will then make the final decision as to acceptability of the proposed new product. The Department will neither be liable for any delay in acting upon any request for approval of a new product nor for any failure to accept any request pursuant to this subsection.

When the Special Provisions limit product selection to only those listed on the Approved Products List, other products will not be evaluated or approved.

## **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 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. The contractor shall comply with Drug-Free Workplace Act, Americans with Disabilities Act, OSHA, and all other pertinent laws relating to conditions of employment.

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 Title 41, Article 4, Archaeological Discoveries, Sections 41-841, et seq., of the Arizona Revised Statutes, 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.

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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

### **107.06 Historic Preservation:**

The attention of the contractor is directed to Title 41, Chapter 4.2, Historic Preservation, Section 41-861 et seq., Arizona Revised Statutes, 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.

### **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:

- (1) 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.
- (2) Barricade the area and provide traffic control, if necessary, to prohibit unauthorized entry.
- (3) 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.

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



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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:**

The contractor shall at all times so conduct its work as to insure 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.

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. Environmental Protection Agency (EPA), the Arizona Department of Environmental Quality (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 submit a Safety Plan at the preconstruction conference. 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; and
- (5) Security procedures to prevent theft, vandalism, and other losses at the construction site.

The Engineer will review the Safety Plan within 10 working days and identify any additional items to be included. 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.

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 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.

In conjunction with the Safety Plan, 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 four 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

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replaced with new materials. No direct payment will be made for furnishing or installing temporary fencing. Permanent fencing will be reimbursed 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.

### **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.

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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, Arizona Revised Statutes 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 USDA Forest Services (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 designated in the Special Provisions.

Additional requirements of the National Forest may be specified in the Special Provisions and may include a clearing plan, a mining plan, and an erosion control and seeding plan.

Unless provided for otherwise 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 forest 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.

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.

#### **(B) Fire Plan:**

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 take action on any and all fires within the right-of-way and work areas and within a half-mile zone adjacent

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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 this plan.

Equipment will be operated by employees of the contractor. The Forest Service will assume no responsibility toward such equipment for ordinary wear or damage due to negligence, carelessness, or willful misconduct.

### **(2) Personnel:**

The contractor shall provide the Forest Service Officer with a list of the names of key personnel who will act in the matter of fire prevention and fire suppression. The Forest Service Officer will provide the contractor a similar list of names. Each list shall be kept current as to the names, addresses and phone numbers.

### **(3) Reimbursement:**

Reimbursement to the contractor or the contractor's employees 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, subcontractor, or their employees for the suppression of fires started by them.

The contractor and the contractor's employees, 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 and the contractor's employees may be called upon to suppress fires on other National Forest lands outside the normal half-mile zone. The contractor and its employees 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.

### **(4) Tool Cache:**

The contractor shall furnish and maintain a tool cache at the active work sites as designated by the Forest Service Officer. Each tool cache shall contain five long-handled (Round Point, size No. 1) shovels, five Mcleod tools and two pulaskis with sheaths. These tools

are required separate from, and in addition to, the tools required on equipment.

**(5) Vehicles:**

All vehicles on the project, except those capable of building fire line and fuel or service trucks, shall have a minimum of one long-handled, size No. 1, round-pointed shovel; one ax or pulaski with sheath; and not less than one 2-1/2 pound capacity, ABC triple class, dry chemical fire extinguisher.

All earth moving equipment, such as dozers and scrapers, shall have a 5-1/2 pound capacity, ABC triple class, dry chemical fire extinguisher.

All service and fuel trucks shall be equipped with a 10-pound capacity, ABC triple class, dry chemical fire extinguisher and one long-handled, size No. 1, round-pointed shovel.

All internal combustion engines, including those on tractors, jammers or any stationary or mobile equipment, shall be equipped with a spark arrester of a type approved by the Forest Service. 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 insure that spark arresters or turbocharger are in working order. All operators shall submit their equipment to the Forest Service Officer for inspection upon request.

All 1975 and later model passenger vehicles and pickups equipped with a catalytic converter will 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.

**(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



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restricted to areas a minimum of two 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 traveling except when traveling on a graveled, oiled or otherwise surfaced road. Vehicles shall be equipped with ash trays. 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) Chain Saws:**

Chain 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 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 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.

When the fire danger is Manning Class 3 and above, each work area shall be patrolled by the contractor for at least one hour after the cessation of power saw operations.

### **(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 Arizona Department of Environmental Quality, Office of Air Quality.

### **(9) Fires:**

No 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.

### **(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, 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 half-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. Immediately following welding and metal cutting operations, and before leaving the site, careful inspections shall be made to detect and extinguish smoldering materials. A five- or 10-gallon container of water with pump shall be available to all welding operations.

#### **(12) Blasting:**

Electric caps will be required; however, under certain conditions, and with prior approval of the Forest Service Officer, fuse caps may be used. Primer cord shall be understood to be an explosive and not fuse.

#### **(13) Forest Closure:**

Fire Manning classes, as established by the Forest Service and based on fire weather and fuel models, will be used by the Forest Service Officer in determining curtailment of operations.

A notification system will be provided to inform the contractor of the predicted Fire Manning class and the fire precautions required. Each day of operation, when there is a predicted change in the Fire Precaution Plan, the Forest Service will inform the contractor between 3:00 and 6:00 p.m. MST of the Numerical Fire Manning class to be followed the next day within the local operation area. The Forest Service will, no later than 9:00 a.m. MST the following day, advise the contractor if conditions have changed from those predicted. The contractor's operations will be governed by the following Fire Prevention Schedule:

Fire Manning Class	Description of Precaution Required
0, 1, 2	Normal Fire Precautions
3	Normal Fire Precautions, except designated areas for smoking and warming or cooking fires require a written permit.
4	Shut down from 12:00 noon until 8:00 p.m. MST all machine treatment of slash, skidding, road pioneering, clearing, and loading. No smoking, warming or cooking fires permitted at any time.  Power saws will shut down from 9:00 a.m. until 8:00 p.m. MST. Operations on mineral soil may continue if approved by the Forest Service Officer.
5	Shut down all operations; except operations on mineral soil may continue with special Forest Service permit.
Red Flag Conditions	Total shut down of all operations with everyone to leave the permitted area except the Fire Protection Officer.
Area Closure Proclaimed by Regional Forester	Total shut down of all operations and area closed to entry. Advance notice will be given as soon as area closure appears a reality, followed by a meeting convened to discuss the situation at that time.

The criteria for establishing the existence of Red Flag Conditions is when sustained high winds are predicted or are occurring. A Red Flag Day identifies those few critical days throughout the fire season that strong winds and low humidity constitute an unusual threat to the national forest resources.

Under unusually severe conditions or with operations that constitute an unusual risk, the Forest Service Officer may institute any or all of the above stipulations, or may require additional action in certain specialized cases.

In specific instances where it can be adequately demonstrated that little or no risk is incurred, the Forest Service Officer may permit certain construction activities to take place under carefully controlled conditions.

**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 or incorporated city, its officers and employees, within the limits of which county 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 executed by a company holding a certificate of authority to transact insurance business in the State of Arizona and acceptable to the Department. The certificate of insurance shall be on the form provided by the Department and shall state that with respect to the contract awarded the contractor, the contractor carries insurance in accordance with the requirements of this subsection.

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 \$1,000,000.00 each occurrence applicable to all premises and operations. 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.

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- (B) Comprehensive Automobile Liability insurance with a combined single limit for bodily injury and property of not less than \$1,000,000.00 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 \$100,000.00. 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 Arizona Revised Statutes 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 Section  
1651 West Jackson Street, Room 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:**

The contractor's attention is directed to the requirements of Arizona Revised Statutes 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 may wish to 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 identified. 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.

At points where the contractor's operations are adjacent to properties of 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 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.

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

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may be incorrect. The contractor shall furnish the Engineer with evidence that the contractor has contacted the utility companies and shall furnish the Engineer with a copy of the information furnished it 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, 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.

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.

When the operations of the contractor result in any 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.

In the event of interruption to water 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.

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.

### **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 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, including 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.



**(B) Compliance Requirements:**

By submission of a bid, the contractor warrants that the contractor and all proposed subcontractors are and shall remain in compliance with all federal, state and local immigration laws and regulations relating to the immigration status of their employees who perform services on the contract. The State may, at its sole discretion, require evidence of compliance from the contractor or subcontractor. Should the State request evidence of compliance, the contractor or subcontractor shall have ten working days from receipt of the request to supply adequate information.

The Department will accept, as evidence of compliance, a showing by the contractor or subcontractor that it has followed the employment verification provisions of the Federal Immigration and Nationality Act as set forth in Sections 274A and 274B of that Act, including implementation of regulations and agreements between the Department of Homeland Security and the Social Security Administration's verification service.

**The contractor shall include the provisions of Subsection 107.19 in all its subcontracts.**

**(C) Sanctions for Non Compliance:**

Failure to comply with the immigration laws or to submit proof of compliance constitutes a material breach of contract. The Department will reduce the contractor's compensation by \$10,000 for the initial instance of non-compliance by the contractor or a subcontractor. Should the same contractor or subcontractor commit subsequent violations within a two-year time period from the initial violation, the contractor's compensation will be reduced by \$50,000 for each violation. The third instance by the same contractor or subcontractor within a two-year period may result, in addition to the \$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, the Department may debar a contractor or subcontractor who has committed three violations within a two-year period for up to one year. For purposes of this paragraph, a violation by a subcontractor does not count as a violation by the contractor.

Any delay resulting from 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 sanction under this subsection.

An example of the 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 *
* May, in addition, result in removal of the subcontractor and/or debarment of the subcontractor.			

## 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 Arizona Revised Statutes 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 issue the entity a proposal pamphlet, 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

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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.

The Engineer will not consent to subletting of any portion of the contract if a copy of the subcontract or lower tier subcontract is not received. 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.

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 Arizona Revised Statutes 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:

<b>Contract Size (Dollars)</b>	<b>Calendar Day Period</b>
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 salient features of 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 for the review and approval of the Engineer; the inspection of structural steel fabrication; and the contemplated dates for the completion of the said salient features. The schedule may be in a bar chart format or a critical path method format. No schedule activity shall be shorter than one day or longer than 15 working 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 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 when structural steel fabrication inspection is required.

If the contract requires trainees on the project, the contractor shall submit a schedule showing the number of trainees, the hours and the work items for which trainees will be used.

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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. 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.

The contractor shall submit a safety plan and designate an employee as Safety Supervisor, in accordance with Subsection 107.08.

Both plans must 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, 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), 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).

### **108.04                    Prosecution and Progress:**

The contractor shall start the work in accordance with the requirements of Subsection 108.02. The contractor shall notify the Engineer at least 24 hours before beginning work.

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 all construction activities and phases of work for the forthcoming two week period. This written schedule shall detail the start and anticipated completion dates of major phases of work as well as indicate the status of major ongoing activities. Minutes of the weekly meetings will be kept by the Engineer and a copy given to the contractor. Failure to provide an accurate, appropriate schedule may be grounds for the suspension of the work.

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 60 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 insure 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

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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, 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, 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.



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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, the daily time charge 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.

Permitting the contractor to continue and finish the work or any part of it after the time fixed for its completion 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.

<b>SCHEDULE OF LIQUIDATED DAMAGES</b>			
Original Contract Amount		Liquidated Damages Per Day	
From More Than:	To and Including:	Calendar Day or Fixed Date:	Working Day:
\$ 0	\$ 100,000	\$ 350	\$ 500
100,000	500,000	490	700
500,000	1,000,000	840	1,200
1,000,000	2,000,000	910	1,300
2,000,000	5,000,000	1,190	1,700
5,000,000	10,000,000	1,540	2,200
10,000,000	-----	2,380	3,400

#### **108.10 Termination of Contract for Default:**

If the contractor:

Fails to begin the work under the contract within the time specified, or

Fails to perform the work with sufficient workers and equipment or with sufficient materials to insure the prompt completion of said work, or

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

Discontinues the prosecution of the work, or

Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

Becomes insolvent, or

Allows any final judgment to stand against it unsatisfied for a period of 10 days, or

Makes an "assignment for the benefit of creditors," or

Fails to comply with contract requirements regarding minimum wage payments or equal employment opportunity requirements, or

Is a party to fraud, or

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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. Thus, damages to which a contractor may be entitled as a result of an improper default termination will be limited to the amounts provided for in Subsection 108.11.

### **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, and
  - (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.

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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 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:
  - 1) Accounting, legal, clerical, and other expenses reasonably necessary for the preparation of termination settlement Proposals and support data;
  - 2) The termination and settlement of subcontracts and orders for materials, services, equipment and facilities; and
  - 3) 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:
  - 1) All unliquidated advance or other payments to the contractor under the terminated portion of the contract;

- 2) Any claim that the Department has against the contractor under the contract; and
- 3) 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.

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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 nine 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 six feet in width, eight feet in length and seven 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



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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. 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 \$10,000.00, 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

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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) 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, notwithstanding 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, set forth in the Rental Rate Blue Book (RRBB) for Construction Equipment which is published by the Equipment Guide-Book Company, a division of Nielson - Dataquest, 1290 Ridder Park Drive, San Jose, California 95131, Phone (800) 669-3282. All rate determinations will be based on the Blue Book rental rate chapter 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 as shown in the Special Provisions.

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.

**(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:

$$[\text{Rental Invoice} \times 1.10] + \text{HOC}$$

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) Statements:**

All statements shall be accompanied and supported by receipted invoices for all materials used and transportation charges. 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 statements 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.

The contractor and subcontractor will submit an equipment list for all equipment to be used during the contract, an equipment rate sheet, and a labor rate sheet, all within 30 days after contract award, but prior to the start of any force account work.

The contractor shall submit payrolls and other cost data documents for all force account work within 30 calendar days after completion of the work. No partial payment will be made. All invoiced work must have documentation for payment. Final payment will not be made for work performed on a force account basis until the contractor has furnished duplicate itemized statements of the cost of such force account work detailed to the following:

Name, classification, date, daily hours, total hours, rate and amount for each foreman and laborer.

Designation, dates, daily hours, total hours, rental rate and amount for each unit of equipment.

Quantities of materials, prices and amounts.

Transportation charges on materials, FOB jobsite.

**(7) Force Account Work by Subcontractors:**



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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 five percent of the subcontractor's costs. Such allowance will be applied to the subcontractor's force account costs less its markups for overhead and profit.

### **(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.
- (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.

### **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. 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) Partial Payment:**

The contractor shall make prompt partial payments to its subcontractors within seven days of receipt of payment from the Department in accordance with the requirements of Arizona Revised Statutes Section 28-6924 Paragraph A.2.

**(2) Final Payment:**

The contractor shall make prompt final payment to each of its subcontractors all monies, including retention, due the subcontractor within 14 days after the subcontractor has satisfactorily completed all of its work.

**(3) Non-compliance:**

If prompt partial payment, or prompt final payment including any retention, is not made within the time frames established above, the Department will retain \$2,000 per subcontractor, per occurrence. Each additional month that payment is not made constitutes an additional occurrence. The amount withheld by the Department will be released after the issue is resolved.

**(C) Payroll Submittals:**

If, by the 15th of the month, the contractor has not submitted its payrolls for all work performed during the preceding month, the Engineer will provide written notification of the discrepancies to the contractor. For each payroll document that the contractor fails to submit within 10 days after the written notification, the Department will retain \$2,500.00 from the progress payment for the current month. The contractor shall submit each complete and correct payroll within 90 days of the date of written notification. If the payroll is complete and correct within the 90-day time frame, the Department will release the \$2,500.00 on the next monthly estimate. For each payroll that is not acceptable until after the 90-day time frame, the Department will only release \$2,000.00 of the \$2,500.00 retained. The Department will retain \$500.00 as liquidated damages. These liquidated damages shall be in addition to all other retention or liquidated damages provided for elsewhere in the contract.

**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.

<b>Partial Payment</b>	
<b>Type of Material</b>	<b>Factor</b>
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
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.

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No partial payment will be made for materials stockpiled at a commercial source.

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, 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:**

When the Bidding Schedule contains items, shown with an alpha or numeric suffix, and approximate quantities required to complete specific structures or designated groups of structures, the contractor will be compensated 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. 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 Bidding Schedule item has been established, payment for this work will be made in accordance with the requirements of Subsection 104.02.

**(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).

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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, 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 table shown in Subsection 601-6, for material which fails to meet the required 28-day compressive strength when sampled in accordance with the requirements of Subsection 1006-7.

**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) is used for asphaltic concrete. Subsection 109.11(C) is used for thickness of Portland cement concrete pavement, and Subsection 109.11(D) 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 shall be as given in individual specifications.

**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 the individual test results of 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.

$$s = \sqrt{\frac{\sum [( \text{Individual Test Results} - \text{AVE} )^2]}{\text{Number of Tests} - 1}}$$

**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. 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. Standard deviation will be reported to two decimal places.

$$s = \sqrt{\frac{\sum [(\text{Thickness Measurement for each Core} - \text{AVE})^2]}{\text{Number of Cores} - 1}}$$

**Lower Limit (LL):** The required thickness less 0.2 inches.

**Lower Quality Index (QL):**

$$QL = \frac{\text{AVE} - \text{LL}}{s}$$

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.

$$s = \sqrt{\frac{\sum [(\text{Compressive Strength Result for each Sample} - \text{AVE})^2]}{\text{Number of Samples} - 1}}$$

**Lower Limit (LL):** The specified minimum strength.

**Lower Quality Index (QL):**

$$QL = \frac{\text{AVE} - \text{LL}}{s}$$

QL will be determined to three decimal places.

**Percent of Lot Within Limits (PWL):**

Determined by entering the appropriate "N" value table with QL.

<b>DETERMINATION OF PU, PL, or PWL</b> <b>Number of Tests "N" = 3</b>			
<b>QU or QL</b>	<b>PU, PL, or PWL</b>	<b>QU or QL</b>	<b>PU, PL, or PWL</b>
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
0.374 to 0.407	61	-1.080 to -1.091	11
0.340 to 0.373	60	-1.092 to -1.103	10

<b>DETERMINATION OF PU, PL, or PWL</b> <b>Number of Tests "N" = 3</b>			
<b>QU or QL</b>	<b>PU, PL, or PWL</b>	<b>QU or QL</b>	<b>PU, PL, or PWL</b>
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

<b>DETERMINATION OF PU, PL, OR PWL</b> <b>NUMBER OF TESTS "N" = 4</b>			
<b>QU or QL</b>	<b>PU, PL, or PWL</b>	<b>QU or QL</b>	<b>PU, PL, or PWL</b>
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

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
0.585 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
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

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
0.896 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
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

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
1.309 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
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
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

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
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
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



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
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
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

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
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

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
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
0.013 to 0.038	51	-1.950 to -2.175	1
0.000 to 0.012	50	-2.176 or Less	0

**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.

**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:

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 five feet outside of structures and excavation and embankment slope lines.

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 five 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 five or more feet above the natural ground line, all trees, stumps and roots shall be cut off not more than one 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.

## SECTION 201

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.

### **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.

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation and other debris, the contractor shall comply with the requirements of Title 36, Public Health and Safety, Chapter 6, Article 8, Air Pollution, of the Arizona Revised Statutes and with the Rules and Regulations for Air Pollution Control, Article 7, adopted by the Arizona Department of Health Services pursuant to the authority granted by the Statutes.

Burning will be permitted only after the contractor has obtained a permit from the Arizona Department of Health Services 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 items.

**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.

## SECTION 202

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).

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 disposed of as 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. The milled material shall be removed and disposed of as 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.



## SECTION 202

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 five 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).

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 Special Provisions. Bridge removal operations shall be conducted in such a manner as to cause the least interference to public traffic.

At least ten 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. Steel members shall be match marked as directed by the Engineer.

Piling, piers, abutments, footings and pedestals shall be removed to at least one foot below ground line or five 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 and saw cutting may be used for removing, widening, or modifying bridges provided the contractor complies with all protection, safety and damage requirements.

Explosives shall not be used in bridge removal operations unless approved by the Engineer.

Before beginning concrete removal operations involving the removal of a portion of a monolithic concrete element, a saw cut approximately one

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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 as provided in Subsection 202-3.03(A).

### **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.

### **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 either from commercial or other sources and 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.

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.

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.

#### **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.

#### **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.

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, compaction of base material resulting from the work under Subsection 202-3.03(C), and the salvaging, hauling, storing and disposing of all materials as provided herein.

### **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,

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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.

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 five 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 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 five 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, 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 five 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. 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.

**203-3                    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.

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 six 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

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manner approved by the Engineer and in accordance with Subsection 107.11.

During construction, the roadway shall be maintained in a well-drained condition at all times.

The top six 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).

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 six 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:**

Overshooting or any method of blasting that might cause damage to the roadway section or highway structures, or that might be dangerous or

destructive to adjacent property or landscape, will not be permitted. The contractor shall provide and install suitable protection for all trees, shrubbery, pole lines and other existing facilities within the adjacent area.

## **(2) Controlled Blasting:**

When controlled blasting is specified in the Special Provisions, all blasting in connection with roadway excavation shall be performed in accordance with the requirements of these specifications. Should the Engineer determine that controlled blasting procedures are to be followed, and such procedures are not specified in the Special Provisions, payment for any additional work will be made in accordance with Subsection 104.02.

Prior to any blasting operations that require controlled blasting, the contractor shall furnish the Engineer a written statement setting forth the details and materials to be used in the pre-splitting operations. The written statement shall include spacing of the drill holes, depth of the holes, amount of explosives to be used in each hole, method of loading, stemming depth, and the time delay between detonations. If the initial results obtained using the proposed method are satisfactory in relation to the character of the material to be pre-split, the procedures shall be continued. If, in the opinion of the Engineer, the results of the blasting are considered unsatisfactory for any reason, the contractor shall submit corrective modifications of the plan to the Engineer for review.

Drill holes for pre-splitting shall be spaced at centers not exceeding three feet and shall be drilled as near to the design slope lines and as parallel to one another as possible. Pre-drilling and pre-splitting to depths greater than one lift (approximately 20 feet) will be permitted only if satisfactory hole alignment is maintained.

Explosive charges placed in slope-drilled holes shall be uniformly spaced along the length of hole and shall be as light as possible to effect clean splitting of the rock along the plane of the slope and to minimize the fracturing of the remaining rock face or cut.

Loading of slope-drilled holes shall be by string charges connected so that all charges in a hole and all holes in the designated section are exploded simultaneously. Explosives for pre-splitting shall be detonated at least several milliseconds in advance of primary blasting. Primary blasting shall be accomplished by means of millisecond delay excavation blasting methods.

## **(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.



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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.

### **(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.

Surplus material shall not be removed from the job site until the work specified in Subsection 203-1 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. 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, 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.

When unsuitable material is removed, as specified in Subsection 203-3.03(D), payment for this work will be in accordance with the requirements of Subsection 104.02. 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. 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, 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.

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Payment for grader ditches and crown ditches will be made as specified under Subsections 203-6 and 203-7, 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.

##### **(B) Geocomposite Packaging, Handling, and Storage:**

The identification, packaging, handling, and storage of the geocomposite wall drain material shall be in accordance with ASTM D 4873. 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, 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 two feet below grade and replaced with structure backfill conforming to the requirements of Subsection 203-5.03(B).

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

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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.

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 shall have a value of resistivity not less than 2,000 ohm-centimeters. 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 Arizona Test Method 236.

Structure backfill material shall conform to the following gradation (Arizona Test Method 201):

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.

**(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 (Arizona Test Method 201):

<b>Sieve Size</b>	<b>Percent Passing</b>
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.

### **(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 two 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 six 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

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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 eight inches in depth before compaction.

Backfill material placed as a slurry shall be placed in uniform layers not exceeding four 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).

### **(4) Compaction of Backfill:**

Backfill material shall be compacted to 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.

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, wing walls, retaining walls, and 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 four 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 four 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 four-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 three-inch wide, waterproof plastic tape.

Where vertical splices are necessary at the end of a geocomposite roll or panel, an eight-inch wide continuous strip of geotextile fabric may be placed, centering over the seam and continuously fastened on both sides with the three-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 cuspatations approximately two inches. For overlapping in this manner, the fabric is then lapped over and tightly taped beyond the seam with the three-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 four-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 eight inches in from the edge with a continuous strip of three-inch wide, waterproof, plastic tape and folding the remaining four 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 four-inch overlap on all sides, and taping it in place with three-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



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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), such additional excavation which is less than three 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 three 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), will be made in accordance with the provisions of Subsection 104.02.

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.

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### **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 eight 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. The material shall be of a quality

suitable for the purpose intended, free of vegetation or other unsatisfactory material. Borrow placed within three 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.

### **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. 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, 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 and compacting the material, and applying water.

### **203-10 Embankment Requirements:**

#### **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

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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      Embankment Materials:**

#### **(A)      Metal Pile Locations:**

Where metal piles are to be driven through a newly placed embankment, the embankment material within ten 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 Arizona Test Method 236.

#### **(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. 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.

### **203-10.03      Embankment 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 three 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. 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, 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 six 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 eight 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 eight-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 two 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.

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Embankment material containing broken concrete, rock, or other solid materials which are larger than six inches in greatest dimension shall be placed so that no surface of said material is within three 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 six 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)(1), 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 seven feet. Embankments deeper than seven 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 two 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).

### **(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 five feet or less in height are to be constructed, the top six 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). 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 six 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.

## **(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, or 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.



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### **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.

#### **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 as described and specified herein, complete in place.

### **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. 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.

**205-3.03 Embankment:**

The placement and compaction of embankment shall conform with the requirements of Subsection 203-10.

**205-3.04 Compacting and Finishing:**

The top six 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

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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 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 will be measured as a single complete lump sum item.

**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 BLANK**

**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. 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:**

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The identification, packaging, handling, and storage of the geotextile fabric shall be in accordance with ASTM D 4873. 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 according to Subsection 406-6. 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 two 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. 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 209 FURNISH WATER:**

**209-1 Description:**

Except as specified below, the work under this section shall consist of furnishing all water required for construction within the project limits. This work shall include securing and transporting water to the project site. All costs, and all labor, equipment, and materials required to secure, transport, and furnish water to the project limits, including, but not limited to, hauling, pumping, and piping water to the project site from canals, rivers, lakes and wells, shall be considered as included in the work.

The work under this section shall also include furnishing all water, as specified above, for the control of dust as considered necessary for public safety and convenience of the traveling public, for the reduction of the dust nuisance to adjacent property, for the allaying of dust in non-commercial crusher and pit operations and on roads used to haul material, and for other purposes as directed by the Engineer. When included in the contract or approved by the Engineer, this item shall also include furnishing water to the project site for those pre-wetting areas specified in the special provisions, or as approved by the Engineer.

Water used for materials prepared in an onsite mixing or processing plant, such as concrete, lean concrete base, or soil cement, will not be included in this work.

Water used in landscape establishment, as specified in Section 807, will not be included in this work.

**209-2 Blank**

**209-3 Construction Requirements:**

The use of pressure pumps and spray bars on all sprinkling equipment used on the project will be required. The use of gravity flow spray bars and splash plates will not be permitted for dust control operations.

Water for use in compaction or for pre-wetting shall be applied in accordance with Section 203, and the special provisions.

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.

Water conservation by using alternative dust control treatments is encouraged. The contractor may propose alternative dust suppressants for subgrades, embankments and other areas within the project, for haul roads, or for controlling dust at equipment yard sites. When the use of chemical dust suppressants is proposed in lieu of water, the

contractor's submittal shall be in accordance with the value engineering process as specified in Subsection 104.13.

**209-4 Method of Measurement:**

The work will be measured by the unit of 1,000 U.S. gallons of water (MGAL). Measurement will be made by means of sealed and certified flowmeters.

For small quantities, or where a sealed flowmeter is not feasible, measurements can be made in tanks or tank trucks of certified capacity, or by other means, if approved by the Engineer.

**209-5 Basis of Payment:**

The accepted quantity of water used in construction, and for control of dust and, if required, for pre-wetting, secured and transported to the project site, and measured as provided above, will be paid for at the contract unit price, which price shall include all costs, including all labor, equipment, and materials necessary for furnishing water as required.

No payment will be made for the labor, equipment, and materials required for furnishing water from sources located within the project limits.

The contract unit price for Furnish Water will not include payment for application or distribution of the water within the project limits, or for water trucks, hoses, fittings, sprinklers, meters, and any other equipment required to distribute and apply the water, or for the labor involved.

The cost for application and distribution of water required for construction shall be considered as included in other related contract items, such as earthwork, subgrades, base courses, and backfill materials as appropriate.

The costs for distributing and applying water for pre-wetting, if required, including all fittings and equipment, and the labor involved, will be considered as included in the appropriate contract items for earthwork.

The cost for distributing and applying water for dust control, including the water truck and all fittings and equipment, and the labor involved, will be considered as included in other contract items.

Except for mandatory Department-furnished sources, and roads used to haul materials from mandatory Department-furnished sources, no measurement or payment will be made for water or other suppressants used for prevention of dust from any material sources, pit or crusher operations located outside of the project limits, whether contractor-



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furnished sources, commercial sources, or non-mandatory Department-furnished sources, or for related haul roads, the cost being considered as included in other contract items.

Except for mandatory Department-furnished sources, no measurement or payment will be made for water used for pre-wetting off the project site.

No adjustment to the bid price for furnishing water, as specified in Subsection 104.02, will be allowed as a result of a value engineering proposal for alternative dust suppressants.

Payment for chemical dust suppressants, when approved, shall be in accordance with Subsection 104.13. Other alternative dust suppressants, when approved by the Engineer, will be paid for in accordance with Subsection 109.04.

**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 these specifications.

**301-2 Materials:****301-2.01 Lime:**

Lime shall be either a commercial dry hydrated lime or a commercial granular or pelletized quicklime, conforming to the requirements of ASTM C 51. When sampled on delivery, the sample of lime shall conform to the following gradations:

<b>Sieve Size</b>	<b>Percent Passing</b>	
	<b>Hydrated Lime</b>	<b>Quicklime</b>
3/4 inch	100	100
No. 30	95 - 100	
No. 100		0 - 30
No. 200	75 - 100	
<b>Test Method</b>	ASTM C 110	ASTM C 136 (Dry sieving only)

Hydrated lime shall contain not less than 85 percent calcium hydroxide,  $\text{Ca(OH)}_2$ , as determined by ASTM C 25.

Quicklime shall contain not less than 94 percent total available calcium oxide and magnesium oxide ( $\text{CaO} + \text{MgO}$ ), and not less than 90 percent total available calcium oxide ( $\text{CaO}$ ), as determined by ASTM C 25.

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 will be specified in the Special Provisions.

**301-2.02 Water:**

Water used for mixing shall conform to the requirements of Subsection 1006-2.02.

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### **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.

### **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 not varying more than 10 percent from the rate specified in the Special Provisions. 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.

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 two 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 five percent of untreated dirt clods larger than one 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 eight inches. Where the required thickness is more than eight 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 sheepfoot 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 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

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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. 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.

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 these 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.

#### **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.

### **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 two 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 thickness of a compacted layer shall not exceed eight inches. 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 four inches or more of aggregate base over the cement treated subgrade, the aggregate base may be used as



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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 subbases and aggregate bases shall conform to the requirements shown in the following table for the class specified:

**TABLE 303-1**

Class of Aggregate	Percent Passing Sieve (Inch or No.)							PI, Max.
	3	1-1/2	1	3/4	1/4	8	200	
1			100	90 - 100		35 - 55	0 - 8.0	3
2		100	90 - 100			35 - 55	0 - 8.0	3
3								
4	100				35 - 70		0 - 10.0	5
5	100				30 - 75		0 - 10.0	5
6								

**Notes:**

- (1) The percentage, by weight, passing each sieve will be determined in accordance with the requirements of Arizona Test Method 201.
- (2) The PI (Plasticity Index) will be determined in accordance with the requirements of AASHTO T 90.
- (3) Classes 1, 2 and 3 are bases; Classes 4, 5 and 6 are subbases.
- (4) The requirements for Class 3 and for Class 6 will be specified in the Special Provisions.
- (5) For Class 1 through Class 4 aggregate, the amount of fractured coarse aggregate particles shall be at least 30 percent, when tested in accordance with the requirements of Arizona Test Method 212.
- (6) 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 9 percent at 100 revolutions

Maximum loss of 40 percent at 500 revolutions

When production of Class 1 through Class 4 aggregate requires composite mixing of materials from more than one source to meet the gradation requirements of Table 303-1, the material from each source shall meet the abrasion requirements specified in 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

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placed and spread on the prepared subgrade, subbase or base in a uniform layer or layers not exceeding six 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.

### **303-3.02            Compaction:**

Each layer of aggregate subbase and aggregate base 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.

### **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  $\pm 0.04$  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.

### **303-4                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 for the class or classes involved, 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 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.

**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.

**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.

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### **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 two 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

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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 four 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.



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<b>TABLE 304-1</b>	
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
*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.

#### 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 or a combination of fine and coarse aggregate for Portland cement concrete conforming to the requirements of Subsection 1006-2.03.

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 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.

**305-2.04           Curing Compound:**

Curing compound shall be Type 2, Class A liquid membrane-forming compound conforming to the requirements of Subsection 1006-2.05.

**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).

**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

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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).

### **(C) Admixtures:**

Admixtures shall be proportioned in accordance with the requirements of Subsection 1006-4.02(D).

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 four percent, nor more than seven 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 seven 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.

**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.

**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 two 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 except that Subsection 401-3.04(F), Surface Texturing, 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.

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.

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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.

### **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 four-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:

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.

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.

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.

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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.

<b>TABLE 305-1 ADJUSTMENT IN CONTRACT UNIT PRICE FOR DEFICIENCY IN THICKNESS OF LEAN CONCRETE BASE</b>	
<b>Average Core Length, Less Than Specified Thickness: Inches</b>	<b>Unit Price Allowed: Percent of Contract</b>
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
* 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

\* 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.

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.

## **SECTION 306 GEOGRID BASE REINFORCEMENT:**

### **306-1 Description:**

The work under this section shall consist of furnishing and placing a geogrid material within or below the aggregate base 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.

#### **306-2.02 Geogrid Packaging, Handling, and Storage:**



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The identification, packaging, handling, and storage of the geogrid material shall be in accordance with ASTM D 4873. 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, 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 zero 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 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 and finished according to Subsection 303-3.03 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 with securing pins is required at all joints (both transverse and longitudinal). Longitudinal joints shall be located

according to the requirements shown in Subsection 406-6 for pavement joints unless otherwise approved by the Engineer. At transverse joints, the preceding roll shall overlap the following roll in the direction that the aggregate base will be placed. Securing pins shall be 3/16-inch steel bars, 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. U-shaped pins shall be another option as approved by the Engineer.

The length of the securing pins shall be four-inch minimum. The geogrid shall be tensioned by hand and anchored to the ground 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. 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 should be allowed on the grid until there is a minimum of six 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 insures 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. 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

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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 as shown on the project plans. No payment will be made for geogrid base reinforcement rejected due to either contamination or damage due to either the fault or negligence of the contractor.

## **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.

#### **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 D 4873. 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, 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-two-inch material that was excavated from the trench, provided

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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 six 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 two inches of the edge drain trench shall be filled with hot asphaltic concrete, meeting the material requirements of Section 409, 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 these specifications.

The contractor shall proportion, mix, place, finish, and cure concrete in accordance with the requirements of these 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. Concrete shall be Class P.

Materials for expansion joint filler and joint seal shall conform to the requirements of Section 1011 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. 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 A 615, Grade 40. When epoxy coated reinforcing steel is designated, it shall conform to the requirements of Subsection 1003-5.

Liquid membrane curing compound shall conform to the requirements of Subsection 1006-2.05.

**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 detailed sequence and schedule of concrete placement operations including, but not necessarily limited to; width of pavement to be placed, proposed equipment, production rates,

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working hours, concrete hauling, placement methods, curing, sawing and sealing methods.

A detailed staking plan for subgrade controls including offset requirements.

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.

### **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 one gallon per 150 square feet. The curing compound shall be Type 2 with a Class A vehicle conforming to the requirements of Subsection 1006-2.05 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 7 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.

##### **(B)        Slip-Form Method:**

The contractor shall set taut guide lines to control both line and grade.

Slip-form equipment shall be equipped with automatic sensing and control devices and shall operate such that the machine automatically follows the guide line.

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:**



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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 four 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 five 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.

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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 one foot from the pavement edge between adjacent transverse joints. Tie bars shall be placed as specified in Subsection 401-3.05 and the pavement shall be replaced as part of adjacent Portland cement pavement construction.
- (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).

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.
- (4) No part of the track shall be operated within one 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 8000 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 insure 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.

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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 8000 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 five 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  $1/8 \pm 1/32$  inch in width and  $5/32 \pm 2/32$  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  $3/4 \pm 1/8$  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 one gallon per 100 square feet. The curing compound container shall be equipped with a calibrated sight glass for verification of quantities used.

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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 one 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 one 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.

**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.



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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 the following procedure shall apply:

- (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 or water.
- (2) The sealant used shall be silicone joint sealant conforming to the requirements of Subsection 1011-8 and shall be applied in accordance with the manufacturer's recommendations. 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; cost to be considered incidental to the sealant pay item. Any sealant spilled on the concrete pavement shall be removed.
- (3) Immediately prior to applying 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.

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:**

Pavement smoothness shall be evaluated by testing with a profilograph.

Profilograph equipment will be furnished by the Department. All profilograph measurements shall be made by a team composed of one Department employee and one contractor employee. The work shall be shared equally. At the completion of each profilograph run both operators shall sign the profilogram, certifying that they are in agreement that the equipment was found to be operating correctly and that the profilogram is a correct representation of the surface profile.

A pavement Profile Index shall be obtained as soon as possible after concrete placement.

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Two profilograph readings shall be taken in each mainline traffic lane, each distress lane and each ramp lane including tapers. The profilograph readings shall be taken in the vehicle wheel paths, three feet from each lane edge of traffic lanes or 18 inches from the lane edge or pavement edge of distress lanes.

The tested profile shall begin 50 feet prior to the concrete placed during any day's production and shall end 50 feet before the end of the placed concrete. The tested profile will include bridge approaches and 50 feet of any pavement which abuts the new pavement.

If, during any day's production, less than 3,000 lane-feet of pavement is placed, that pavement shall be tested with the subsequent day's production.

The contractor shall broom the pavement or clean the pavement by other approved methods immediately prior to profilograph testing.

Surface profiles will be evaluated by the Department in accordance with the provisions of Arizona Test Method 801. The Profile Index for a traffic lane will be the average of the two Profile Indexes obtained for that lane.

All mainline traffic lanes, distress lanes, ramp lanes and tapers shall have a Profile Index of nine inches or less per mile in any 0.1-mile section.

Payment for mainline traffic lanes will be adjusted in accordance with Subsection 401-6, based on the Profile Index of the traffic lanes.

Profile Indexes greater than nine inches per mile per 0.1-mile section shall be reduced to nine inches or less per mile per 0.1-mile section by grinding or pavement removal and replacement as specified herein.

When pavement will not be overlaid with asphaltic concrete prior to opening to traffic, grinding of pavement which has a Profile Index of nine inches or less per mile per 0.1-mile section will only be permitted to correct deviations in excess of 0.3 inches in 25 feet ("must-grinds") as specified herein and when directed by the Engineer.

The contractor shall remove high pavement areas with vertical deviations greater than 0.3 inches in 25 feet or less. High pavement areas shall be removed with grinding devices or multiple-saw devices as approved by the Engineer. Grinding machines shall be of the rotary type with a wheel base of at least 10 feet and with vertically adjustable grinding wheels. Bush hammers or other impact devices shall not be used.

After removal of high areas, the affected 0.1-mile pavement section shall be reprofiled; however, if the original Profile Index for the pavement section was within the specified range, only that portion of the pavement which originally contained high areas shall be reprofiled.

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 shall be reprofiled 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 shall be reprofiled 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.

In addition to the Surface Profile Index requirements, the pavement surface will be tested with a 10-foot straightedge. The surface shall not vary in any direction by more than 1/8 inch, except at longitudinal and transverse construction joints. The surface shall not vary by more than 1/4 inch across any longitudinal or transverse construction joint. Grinding will be required to insure that these requirements are satisfied.

The pavement shall be ground in a manner that does not form a smooth or polished pavement surface.

All pavement profile repairs shall be made prior to pavement thickness evaluations.

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.

#### **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.

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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.

#### **(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 five 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 five 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 (a) and (b) above, shall be considered unrepairable and the pavement shall be removed and replaced in accordance with the requirements of Subsection 401-4.03(C).

**(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  $\frac{3}{4}$  inch and to a width not less than  $\frac{3}{8}$  inch or more than  $\frac{5}{8}$  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), 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 six 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, four-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-inch 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-inch 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-inch 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 these specifications which may affect thickness shall not be construed to modify such thickness requirements.

Pavement will be evaluated for thickness by the lot. Lot limits will be identical to those specified in Subsection 1006-7.03 for compressive strength of Class P concrete. The contractor shall obtain ten cores per lot, in accordance with Arizona Test Method 317, 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 measurements will be to the nearest thousandth of an inch, and the average of such measurements will be 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 ten 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 one 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 shall 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.



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No separate payment will be made for joints, the cost being considered as included in the contract item for Portland cement concrete pavement.

Cracked pavement slabs which require repair in accordance with the provisions of Subsection 401-4.03 (B) 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 are described in Subsection 401-4.04 and Subsection 1006-7.03. 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 shall 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 shall 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.

When pavement will not be overlaid with asphaltic concrete prior to opening to traffic, the unit price paid for pavement on mainline traffic lanes and freeway-to-freeway ramps which have a Profile Index less than or equal to 9.0 inches per mile per 0.1-mile section after correction of all deviations in excess of 0.3 inches in 25 feet ("must-grinds") will be adjusted in accordance with Table 401-2.

<b>TABLE 401-2</b> (Use when pavement <b>will not</b> be overlaid with asphaltic concrete prior to opening to traffic.)	
<b>Profile Index (P.I.)</b> <b>[inches per mile</b> <b>per 0.1 mile</b> <b>section]</b>	<b>Unit Price Adjustment</b>
7.0 or Less	Plus $(\$0.20) \times [7.0 - (P.I.*)]$ per square yard (\$1.00 Maximum) (See Notes)
7.1 to 8.0	Minus \$0.50 per square yard
8.1 to 9.0	Minus \$1.00 per square yard
Notes: 1. P.I.* = Profile Index (P.I.) rounded to the nearest whole number. 2. The "plus" unit price adjustment will not be made for pavement placed within each 0.1-mile section which has grinding in excess of 1.5 percent of the area included in any traffic lane involved.	

When pavement will be overlaid with asphaltic concrete prior to opening to traffic, the unit price paid for pavement on mainline traffic lanes and freeway-to-freeway ramps which have a Profile Index less than or equal to 9.0 inches per mile per 0.1-mile section will be adjusted in accordance with Table 401-3.

<b>TABLE 401-3</b> (Use when pavement <b>will</b> be overlaid with asphaltic concrete prior to opening to traffic.)	
<b>Profile Index (P.I.)</b> <b>[inches per mile</b> <b>per 0.1 mile</b> <b>section]</b>	<b>Unit Price Adjustment</b>
7.0 or Less	Plus $(\$0.10) \times [7.0 - (P.I.*)]$ per square yard (\$0.50 Maximum) (See Note)
7.1 to 8.0	Minus \$0.25 per square yard
8.1 to 9.0	Minus \$0.50 per square yard
Note: P.I.* = Profile Index (P.I.) rounded to the nearest whole number.	

Unit price adjustments for pavement smoothness will not be made for pavement in distress lanes, shoulders, service interchange ramps, tapers, cross roads, or frontage roads.

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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 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 labor, materials and equipment necessary to repair Portland cement concrete pavement in accordance with the requirements of these specifications and as shown on the project plans or established by the Engineer.

The kind of Portland cement concrete pavement repair may consist of one or a combination of the following:

- Spall Repairs
- Slab Repairs
- Pavement Grinding
- Pavement Grooving
- Joint and Crack Repair
- Edge Sealing

### **402-2 Spall Repairs:**

#### **402-2.01 Description:**

The work shall consist of furnishing all materials and removing loose material and temporary bituminous patch material from potholes, damaged joints, and spalled areas, thoroughly cleaning the repair area

and placing new patch material in accordance with the details shown on the project plans and as specified herein, and in reasonably close conformity with the existing pavement cross-section.

#### **402-2.02 Material Requirements:**

##### **(A) General:**

Patch materials shall attain compressive strength of 2,000 pounds per square inch within six hours. The patch material shall attain the required compressive strength prior to opening to traffic.

##### **(B) Accelerated Strength Portland Cement Concrete Patch Material:**

The patch material shall be an Accelerated Strength Portland Cement Concrete mixture consisting of Type III Portland Cement and calcium chloride or other accelerators meeting AASHTO M 144 and shall attain a compressive strength of at least 2,000 pounds per square inch in six hours. Materials for the concrete mix shall conform to the requirements of Section 1006 for Class S concrete. The coarse aggregate shall be as designated for size No. 67 in accordance with AASHTO M 43.

##### **(C) Rapid Setting Patch Material:**

Rapid setting patch material shall be a product approved by the Engineer. A list of approved patch materials is maintained on the Department's approved product list.

##### **(D) Epoxy Resin Grout Patch Material:**

Epoxy resin patch material shall be a low modulus moisture insensitive epoxy mortar grout prepared in accordance with the manufacturer's recommendations. Fine aggregate incorporated into the grout shall meet the fine aggregate gradation requirements specified in Subsection 1006-2.03 (B). The epoxy binder: aggregate ratio shall be between 1:7 and 1:10. The epoxy binder materials shall meet the requirements specified in ASTM C 881.

##### **(E) Flexible Epoxy Patching Material:**

###### **(1) Description:**

The patching material shall be a mixture of a solventless, medium curing time, stress relieved flexible coating epoxy and 100 percent vulcanized granulated rubber.

###### **(2) Materials:**

The epoxy shall be a two component, low viscosity mixture and have a gray color when mixed. The curing period shall be seven days at

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standard laboratory conditions. The cured epoxy shall meet the following physical requirements:

Test Method Requirements	Test	Material
ASTM D 638	Tensile Strength: psi	900 (minimum)
ASTM D 638	Tensile Elongation: %	85 (minimum)
Gardner	Impact Resistance: pounds Direct Reverse	greater than 160 greater than 80
AASHTO T 237	Tensile Bond Strength: psi	310 (minimum)
ASTM D 648	Heat Deflection Temperature: °F	25
ASTM D 2240	Hardness: Shore D	62 (minimum)
AASHTO T 237	Slant Shear Strength: psi	2,000 (minimum)

The ground rubber shall be free of fabric, wire or other contaminating materials.

### (3) Packaging and Marking:

The ground rubber shall be introduced into each of the two components by the manufacturer at the place of production, not at the job site. Each container of both components shall be labeled and legibly marked with the manufacturer's name, the trade name of the product, component identification and the expiration date of the manufacturer's shelf life warranty. Material that has exceeded the shelf life warranty expiration date shall not be used.

### (4) Certification Requirements:

A Certification of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

## 402-2.03 Construction Requirements:

### (A) General:

Spalled areas to be repaired will be designated by the Engineer and shall be repaired prior to any required pavement grinding. The extent of the repair area will be marked by the Engineer and will be no less than three inches outside the area of delamination. The Engineer will be the final authority if questions arise in regard to the need for patching or the extent of a required patch.

Spalled areas less than six inches in length and 1-1/2 inches in width, which are adjacent to joints, shall not be repaired under this specification.

Patching material shall not be placed under conditions which will adversely affect the quality of work. The Engineer shall be the sole judge in determining the suitability of working conditions.

Concrete within the patch area shall be broken out, to the minimum depth specified for the patch material being used, with light to medium pneumatic tools until sound clean concrete is exposed. If the depth of the spalled area exceeds half the thickness of the concrete pavement slab, the affected pavement shall be removed and replaced, as designated by the Engineer and in accordance with the requirements of Subsection 402-3.

Asphaltic concrete shoulders adjacent to a patch shall be cut longitudinally to the depth of the patch and to a width of not more than 12 inches. The cut shall extend one foot beyond both transverse limits of the patch to facilitate placement of form work. Shoulders shall be patched with material similar to the existing shoulder material.

Prior to patching, the exposed faces of the concrete shall be sandblasted free of loose particles, oil, dust, traces of asphaltic concrete and other contaminants. Prior to placement of the bonding agent, all sandblasting residue shall be removed with compressed air and high suction vacuums. Sand for sandblasting shall be sharp and clean and capable of passing a No. 10 sieve and shall leave the exposed concrete face clean and dry.

The surface of the spalled area or breakup shall be clean and dry so that patching material will form a proper bond. The area to be cleaned and patched shall be limited to the area designated by the Engineer. Patching material shall be confined to the limits of the repair and shall not lap onto the surrounding pavement.

Patch material shall be placed or consolidated to eliminate voids at the interface of the patch and existing concrete. If a partial depth repair area abuts a working joint or crack which penetrates the full depth of the slab, a temporary insert or other bond-breaking medium such as styrofoam strips shall be used to maintain the working joint or crack for the full depth of the patch and at the same width as the existing joint or crack while placing patch material. Repair material shall not bear on an adjacent slab.

The patch shall be finished to the cross-section of the existing pavement and textured with a stiff bristled brush. Texturing shall conform to that of the existing pavement. The patch surface shall be struck off flush with the existing pavement surface.

**(B) Accelerated Strength Portland Cement Concrete  
Pavement Patch:**

Patch boundaries shall be saw cut and broken out to a depth of at least 1-1/2 inches.

Following the removal and cleaning of the area to be patched, and prior to placing patch material, an approved bonding agent shall be applied to the patch area. The bonding agent shall be applied in a thin coating

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and scrubbed into the surface with a stiff bristled brush. Placement of patch material shall be delayed until the bonding agent becomes tacky.

### **(C) Rapid Setting Patch:**

Rapid set patch materials shall be installed in accordance with manufacturer's instructions. In order to assure proper mixing and placement, a qualified manufacturer's representative for the approved product shall be present at the start of spall repair operations, and shall remain until the Engineer is satisfied that the contractor is conforming to the recommended procedures.

Patch boundaries shall be saw cut and broken out to a depth of at least 1-1/2 inches, or as recommended by the manufacturer, whichever is greater.

If recommended by the manufacturer, the area to be patched shall be primed with a bonding agent compatible with the patch material being used.

### **(D) Epoxy-Resin Grout Patch:**

Patch boundaries shall be saw cut and broken out to a minimum depth of 1-1/2 inches.

Prior to placement of epoxy-resin grout, the contractor shall furnish a grout mix design for review and approval.

The epoxy-components shall be mixed in strict compliance with the manufacturer's recommendations before aggregate is added to the mixture.

### **(E) Flexible Epoxy Patch:**

Use of flexible epoxy materials shall be in accordance with the manufacturer's recommendations unless otherwise specified by the Engineer.

The contractor shall remove the spall area to be replaced to a minimum depth of two inches or to a solid surface by saw cutting and chipping with a pneumatic hammer, without damaging the underlying intact concrete. All loose particles shall be removed before applying the flexible epoxy inlay.

The contractor shall mix only the amount of material that can be used before the expiration of the pot life for the material. The two parts shall be thoroughly mixed in their own containers before combining the parts together as recommended by the manufacturer. The contractor shall blend the mix thoroughly for the length of time recommended by the manufacturer, making sure the material contains no lumps or streaks, and carefully scraping the sides and bottom of the container.

The material shall be placed in the area to be patched, the surface leveled off even with the surrounding pavement, and any excess material removed.

**402-2.04 Method of Measurement:**

Spall repairs will be measured by the square foot for all patches constructed. Each patch will be measured to the nearest one-tenth square foot. The total cumulative measurement of all patches will be rounded to the nearest square foot.

**402-2.05 Basis of Payment:**

The accepted quantities of spall 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 repair or replacement of shoulder material which is removed or damaged during spall 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 patches of Portland cement concrete pavement at the locations shown on the project plans, as specified herein, and in reasonably close conformity with the existing pavement cross-sections.

**402-3.02 Material Requirements:**

Patching material shall be an Accelerated Strength Portland Cement Concrete Mixture which includes Type III Portland Cement and calcium chloride or other accelerator conforming to the requirements of AASHTO M 144. The patch material shall attain a compressive strength of at least 2,000 pounds per square inch in six hours. The contractor shall not place concrete patch material until the mix design has been tested and approved by the Engineer.

Materials for Portland Cement Concrete shall conform to the requirements of Section 1006. 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.

Materials furnished for tie bars shall conform to the requirements of Section 1003.



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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 A 615, Grade 40.

Liquid membrane-forming curing compound shall conform to the requirements of Subsection 1006-2.05.

### **402-3.03 Construction Requirements:**

Areas to be repaired will be designated by the Engineer and shall be repaired before any specified pavement grinding. The Engineer shall be the final authority if questions arise with regard to the need for patching or the extent of the patch.

Patching material shall not be placed under any conditions which will adversely affect the quality of the work. If these conditions arise, the Engineer will determine whether or not the operation should cease. The Engineer shall be the sole judge in determining the suitability of working conditions.

Pavement slabs containing multiple cracks through the full depth of the slab, separating the slab into three or more parts and other slabs designated by the Engineer, shall be entirely removed and replaced. 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.

Areas to be patched shall have the configuration and minimum dimensions shown in the plans. The area shall be saw cut to the full depth of the slab. An additional full depth saw cut shall be made interior to one of the initial transverse saw cuts and shall be made such that a wedge tapering from four inches to six inches from the initial cut is created.

The area inside the wedge shall be removed with light to medium weight jackhammers or other approved equipment prior to removing the larger remaining pavement section. The remaining pavement shall be lifted out in a manner approved by the Engineer. Any disturbed granular subbase shall be removed and replaced with concrete patch material and any spalls which are caused by the removal operations and which are greater than one inch wide or one inch deep, shall be repaired by resawing full depth and full width of the traveled lane, or repaired as directed by the Engineer at no additional cost to the Department.

When the patch boundary is at an existing contraction joint, the new joint shall be formed with plain round dowel bars, 1-1/4 inches in diameter and 18 inches in length. Dowel bars shall be placed as shown in the plans, and shall be placed at mid-depth of the existing slab. Holes drilled for the dowel bars shall not be less than 1-3/8 inches in diameter and shall extend nine inches into the existing slab. The bars shall be anchored into the existing concrete with an approved high

viscosity epoxy. Prior to concrete placement for the replacement slab, the nine-inch long free end of the dowel bar shall be uniformly coated with a thin film of heavy waterproof grease.

When the patch boundary is at an existing longitudinal joint, the patch shall be tied to existing concrete with two-foot long No. 5 deformed steel tie bars placed in the joint at 30-inch intervals as shown on the plans. Holes drilled in the existing slab shall be one foot deep and of a diameter sufficient to accommodate the tie bars. The tie bars shall be anchored into the existing slab using an approved high viscosity epoxy.

When the patch boundary is located near mid slab, the patch shall be tied to existing concrete with two-foot long No. 8 deformed steel tie bars placed in the transverse joint at 18-inch intervals and No. 5 deformed steel tie bars placed in the longitudinal joint at 30-inch intervals as shown in the plans. Holes drilled in the existing slab shall be one foot deep and of a diameter sufficient to accommodate the tie bars. The tie bars shall be anchored into the existing slab using an approved high viscosity epoxy.

Patch material shall be placed and consolidated to eliminate voids at the interface of the patch and existing concrete. A new sealant reservoir shall be sawed or formed at the interface of the patch and existing concrete, as shown on the plans.

The patch shall be finished to the cross-section of the existing pavement and textured with a stiff bristled brush to match the existing pavement. The patch surface shall be within 1/8 inch of the existing pavement surface. No texturing will be required if pavement grinding or grooving is to be done after patching.

#### **402-3.04            Method of Measurement:**

Slab Repairs will be measured by the square yard of pavement repaired. Each patch 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 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 removal and disposal of existing materials, the excavation and subsequent backfilling or repairs to subbase materials incidental to the removals and the repair or replacement of shoulder materials which are damaged or removed during the work.

#### **402-4                Pavement Grinding:**

##### **402-4.01            Description:**

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The work shall consist of furnishing all materials and grinding the surface of existing concrete pavement at the locations shown on the project plans and in accordance with the requirements of these specifications.

### **402-4.02        Blank**

### **402-4.03        Construction Requirements:**

#### **(A)        General:**

Prior to grinding, spalled areas shall be repaired as specified. Grinding shall be done prior to any specified sawing and sealing of existing transverse and longitudinal joints.

Pavement surfaces shall be ground longitudinally.

The contractor shall 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 entire area of pavement designated to be ground shall be ground in a manner that results in a uniform surface appearance. Grinding shall continue for the full lane width until the pavement surface on both sides of all transverse joints and all cracks is in the same plane. Longitudinal ridges in adjacent passes of the grinding equipment shall not exceed 1/8 inch in depth.

In any one lane, a maximum distance of 1,000 linear feet of unfinished work area between the lead grinder and the last grinder in that lane will be allowed at the end of any work shift.

Ground surfaces shall not be smooth or polished and shall have a wet Arizona Mu-Meter number of not less than 60 at 40 miles per hour.

The surface shall have a finished texture that has grooves between 0.090 and 0.130 inches wide, spaced 0.060 to 0.110 inches apart and not less than 0.030 inches or more than 0.115 inches in depth.

The ground area of any selected two-foot by 100-foot longitudinal area of pavement specified to be ground shall not be less than 98 percent of the selected area. This selected area will be within the center eleven feet of a traffic lane.

Residue and excess water resulting from grinding shall be removed from the roadway by vacuuming or any other method approved by the Engineer. The residue shall be removed prior to opening the lane to traffic. Residue and water from 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. Dried residue shall be broomed with a pickup or power broom prior to allowing traffic over the opened work area.

After grinding has been completed, the pavement surface will be tested in accordance with the requirements of Arizona Test Method 801. Two Profilograph readings shall be taken in the vehicle wheel paths three feet from the edge of the traffic lane.

To be acceptable, a Profile Index shall not exceed 10 inches per mile in any 0.1-mile section. In addition, all areas representing high points having deviations in excess of 0.3 inches in 25 feet, shall be reground until such deviations, as indicated by reruns of the Profilograph, do not exceed 0.3 inches in 25 feet.

Additional grinding shall be performed, if necessary, to reduce the overall Profile Index, as measured by the Profilograph, to 10 inches per mile in any 0.1-mile section or remaining portion thereof, along any line parallel to the edge of the pavement. In any areas requiring regrinding, the regrinding shall be done over the full lane width.

The contractor shall broom the surface of the concrete so that Profilometer readings can be taken. Profilograph measurements shall be the responsibility of the contractor on all but the final acceptance measurement. The contractor shall bear all costs of profilograph measurements. Traffic control for the final acceptance measurements shall be provided by the contractor.

#### **(B) Equipment and Procedures:**

Grinding shall be done with diamond blades, mounted on a self-propelled machine that has been designed for grinding and texturing of pavements. The equipment shall be designed such that it will not cause strain or damage to the underlying surface of the pavement. Grinding equipment that causes excessive ravels, 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 or grinding head configuration. Overlapping of grinding passes will not be allowed.

The noise level created by any one machine shall not exceed 86 dbA at a distance of 50 feet normal to the direction of traffic.

No equipment will be allowed within three feet of a traffic lane open to the public. Maintenance and Protection of Traffic shall conform to the requirements of Section 701.

#### **402-4.04 Method of Measurement:**

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Pavement grinding will be measured by the square yard of pavement ground and accepted. The quantity will be determined by multiplying the width by the length of the ground area.

### **402-4.05 Basis of Payment:**

The accepted quantities of pavement grinding, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work complete as specified.

### **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.

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 any one machine shall not exceed 86 dbA at a distance of 50 feet normal to the direction of traffic.

##### **(B) Equipment and Procedures:**

Grooving shall be done with diamond blades, mounted on a multi-blade arbor on a self-propelled machine which has been built for grooving of pavements. The groover shall have a depth control device which will detect variations in the pavement surface and adjust the cutting head height to maintain the specified groove depth. The grooving machine shall have alignment control devices. Flailing type grooving will not be permitted.

At the beginning of each work shift, all grooving machines 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 any individual grooving machine 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 any individual grooving machine 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 ninety 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 0.125 inches 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 0.015 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 any device 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

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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 as specified herein.

### **402-6 Joint and Crack Repair:**

#### **402-6.01 Description:**

The work shall consist of furnishing all materials and renovating longitudinal and transverse contraction control joints and routing and sealing random cracks in existing Portland Cement Concrete Pavement, as specified herein, detailed on the project plans and as directed by the Engineer.

#### **402-6.02 Material Requirements:**

Joint sealant shall conform to the requirements of Section 1011.

Grout for filling wide joints shall be a low modulus moisture insensitive epoxy-resin grout of a viscosity suitable for flowing into the irregular cracked portion of the joint. The ratio of epoxy-resin: sand shall be between 1:7 and 1:10 or as specified by the epoxy manufacturer. Epoxy binder material shall conform to the requirements of ASTM C 881.

Sand used in epoxy grout shall conform to the requirements of Subsection 1006-2.03 (B) except that the gradation shall be as follows:

<b>Sieve Size</b>	<b>Percent Passing</b>
No. 8	100
No. 16	95 - 100
No. 50	10 - 40
No. 200	0 - 4.0

A rapid set Portland cement concrete pavement patching material may be substituted for epoxy grout as approved by the Engineer.

#### **402-6.03 Construction Requirements:**

##### **(A) General:**

Joint and crack repairs shall be accomplished by first removing old sealant and joint inserts, then refacing and cleaning the joints and

cracks followed by installation of a backer rod (if required) and installation of new sealant.

**(B) Joint and Crack Preparation:**

Cracks shall be sawed or routed to the dimensions shown on the plans.

Inserts shall be removed from insert formed joints by sawing to provide a clean vertical face. The width and depth of the saw cuts shall be sufficient to insure complete removal of the insert and to provide a finished joint of the dimensions specified for the sealant material to be used. If the insert is not vertical, additional parallel saw cuts shall be provided as required to insure full removal of the inserts.

Joints that are not insert formed shall be sawed to the widths and depths specified herein. Joints previously sawed and sealed will be inspected to assure the proper dimensions and shall be resawed to the proper widths and depths, when required.

Joints shall be sawed as follows:

<b>Initial Joint Width "W": Inches</b>	<b>Sawed Width: Inches</b>	<b>Sawed Depth "D": Inches, (1)</b>
$W \leq 1/2$	1/2	$D = 1-3/4$
$1/2 < W \leq 3/4$	3/4	$D = 2-1/8$
$3/4 < W \leq 1-1/2$	No Sawing Required	$D = 2W + 3/4$
(1) "D" is distance from pavement surface to bottom of backer rod.		

Immediately after saw cutting a joint or routing a crack, old sealant shall be removed and the internal surfaces of the joint or crack shall be thoroughly cleaned by sandblasting. Sand for sandblasting shall be sharp and clean and shall be capable of passing a No. 10 sieve. The amount of compressed air and the nozzle pressure shall be such that the joints and cracks will be thoroughly cleaned and the edges will have etched surfaces.

**(C) Dowel Placement:**

Dowel bars shall be placed in transverse joints when the initial joint width is greater than 1-1/2 inches. Slots for dowel bar placement shall be made with two saw cuts perpendicular to the joint and  $1-1/2 \pm 1/8$  inches apart. Saw cuts shall be one half the depth of the slab plus 1/2 inch. Concrete shall be removed between the saw cuts and smooth, epoxy coated dowels which are 1-1/4 inches in diameter and 18 inches long shall be inserted into the formed slot. Dowels shall be supported above the bottom of the slot so that epoxy grout can flow around the circumference of the dowel. Dowels shall be placed so that the dowel is embedded equal distance into the two slabs. 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 A 615, Grade 40. Dowel bars shall be placed as shown on the



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plans, and shall be placed at approximately mid-depth of the existing slab. The bar shall be thoroughly and uniformly coated with a waterproof grease prior to placement into the slot then covered with an approved epoxy grout. A 1/2-inch thickness of preformed joint filler shall be placed next to one edge of the joint such that a one ± 1/8-inch deep sealant reservoir can be formed at the top, as shown on the plans. The wide joint shall be filled with epoxy grout.

On longitudinal joints where the joint opening exceeds 1-1/2 inches, the saw cuts for placement of tie bars perpendicular to the joint, shall be 7/8 inch apart so that a No. 5 deformed tie bar 24 inches long can be inserted into the slot. This 24-inch tie bar shall be placed at mid slab depth and equal distance into each slab, then covered with an approved epoxy grout. The bars shall be at 36-inch spacing. The wide joint shall also be filled with epoxy grout.

**(D) Cleaning Prior to Sealing:**

Prior to sealing, all foreign or loosened particles shall be removed from the joints to the full depth of the original sawed joints. The removal of all foreign or loosened particles shall be accomplished with compressed air or by other methods approved by the Engineer. Air compressors shall be capable of furnishing a sufficient amount of compressed air to clean the joints properly.

**(E) Separating or Blocking Medium (Backer Rod):**

Immediately following the cleaning of joints and prior to the application of sealant, 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.

The backer rod shall be compatible with the sealant in accordance with the manufacturer's recommendations. The product shall be clean, free of scale, foreign matter, oil or moisture and shall be non-absorbing. The Engineer shall be assured that the material proposed for use has been used successfully in similar installations.

Backer rod sizes shall be as follows:

<b>Joint Width: Inches</b>	<b>Backer Rod Diameter: Inches</b>
1/2	5/8
3/4	1
1	1-1/4
1-1/4	1-1/2
1-1/2	2

**(F) Installation of Sealant:**

Sealant compound shall not be placed unless the joint is dry, clean and free of dust. The face of the joint shall be surface dry and the ambient and pavement temperatures shall both be at least 50 degrees F at the time of application of the sealant. Installation of the sealant shall be such that the in-place sealant shall be well bonded to the concrete and free of voids or entrapped air. The joints shall be sealed in a neat and workmanlike manner, so that upon completion of the work, the surface of the sealant material will be  $1/4 \pm 1/8$  inch below the adjacent pavement surface. The contractor shall refill all low joints before final acceptance. Any excess material on the surface of the pavement shall be removed and the pavement surface shall be left in a clean condition. Vehicular or heavy equipment traffic shall not be permitted on the pavement in the area of the joints during the curing period.

**402-6.05 Method of Measurement:**

Joint and crack repairs will be measured by the linear foot.

**402-6.06 Basis of Payment:**

The accepted quantities of joint and crack repairs, 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 sawing or routing, 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 any specified pavement grinding and after any 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:**

**(A) General:**

The sealant to be used shall be any one of the following:

A mixture of asphalt and 100 percent vulcanized, granulated rubber.

Premixed block material consisting of asphalt and 100 percent vulcanized rubber.

**(B) Ground Rubber:**

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All material shall meet the requirements of these specifications and the contractor shall submit a Certificate of Compliance conforming to the requirements of Subsection 106.05.

Rubber shall be free of fabric, wire or other contaminating materials. No more than four percent by weight calcium carbonate may be included to prevent the particles from sticking together.

Rubber shall meet the following requirements when tested in accordance with Arizona Test Method 714.

<b>Sieve Size</b>	<b>Asphalt Rubber (Vulcanized): % passing</b>	<b>Premixed Asphalt Rubber 100% (Vulcanized): % passing</b>
No. 8	100	100
No. 10	95 - 100	95 - 100
No. 30	0 - 10	

The rubber shall have a specific gravity of  $1.15 \pm 0.20$ .

### **(C) Asphalt Cement:**

#### **(1) Asphalt-Rubber (Vulcanized):**

##### **Type A:**

Asphalt cement shall be an asphalt binder performance grade PG 58-22, conforming to the requirements of Section 1005.

##### **Type B:**

Asphalt cement shall be an asphalt binder performance grade PG 64-16, conforming to the requirements of Section 1005.

### **402-7.03 Construction Requirements:**

#### **(A) Material Mixing Requirements:**

The methods used to combine the materials and the design of the equipment shall be such that the Engineer can readily determine the percentages by weight of the materials being incorporated into the mixture.

#### **(1) Asphalt-Rubber (Vulcanized):**

The mixture shall consist of  $75 \pm 2$  percent asphalt and  $25 \pm 2$  percent rubber by weight.

The materials shall be combined as rapidly as possible for such a time and at such a temperature that the consistency of the mixture

approaches that of a semi-fluid material. Since the time required to achieve this state is a function of the temperature of the asphalt, the time may vary and shall conform to that recommended by the manufacturer.

**(B) Equipment Requirements:**

The equipment used in the application of the asphalt-rubber material shall have a mixing system in the heating unit in order to maintain a consistent, uniform, homogeneous mixture throughout the crack sealing operation. The equipment shall be designed to provide a continuous supply so that operations may proceed without delays.

**(C) Weather:**

The asphalt-rubber mixture shall not be placed during wet weather or under other conditions which will adversely affect the operations. The sealant shall not be placed in cracks which are wet.

If adverse weather conditions are such as to affect the operations, the Engineer will determine whether or not the operations should cease.

**(D) Application of Asphalt-Rubber Sealant:**

The joint shall be sawed in the asphaltic concrete directly adjacent to the edge of the Portland cement concrete pavement and shall be at least 1/2 inch wide and one inch deep.

Immediately prior to placement of the sealant, the joints shall be cleaned as approved by the Engineer.

**402-7.04 Method of Measurement:**

Edge sealing will be measured by the linear foot of longitudinal edge joint sealed.

**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 edge seal, 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:**

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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. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process.

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 three 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 two 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 proportion of each individual component (mineral aggregate, mineral admixture, and bituminous material) incorporated into the mix.

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 a single or multiple course bituminous treatment in accordance with the requirements of these specifications and in reasonably close conformity to the lines shown on the project plans or established by the Engineer.

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The kind of bituminous treatment may consist of one or a combination of the following:

- Prime Coat
- Tack Coat
- Fog Coat
- Chip Seal Coat

**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

Application temperatures of bituminous materials shall conform to the requirements of Table 1005-6.

**404-2.02 Aggregate Materials:**

**(A) General:**

There is no Department-furnished source of aggregate material. The contractor shall provide a source in accordance with the requirements of Section 1001.

Aggregate material will be sampled for gradation acceptance in the final stockpile before incorporation into the work.

The aggregate material will be deemed to be acceptable when the test values for each specified aggregate characteristic are within the specified limits.

**(B) Blotter Material:**

Blotter material shall be a natural sand, crushed sand, volcanic cinders, or other approved material and shall be free of deleterious amounts of foreign substances.

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201:

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 sand, gravel or crushed rock and shall be free from lumps or balls of clay and shall not contain calcareous or clay coatings, caliche, synthetic materials, organic matter or foreign substances.

The gradation shall meet the following requirements for the Class specified in the Special Provisions when tested in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing	
	Class 1	Class 2
1/2 inch	100	
3/8 inch	70 – 90	100
1/4 inch	0 – 10	70 – 90
No. 4	---	0 – 10
No. 8	0 – 5	0 – 5
No. 200	0 - 1.0	0 - 1.0

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	Arizona Test Method 212	Minimum 85% (at least two fractured faces) and minimum 92% (at least one fractured face) determined on plus No. 4 material
Flakiness Index	Arizona Test Method 233	Maximum 20%
Bulk Oven Dry Specific Gravity	Arizona Test Method 210	2.350 – 2.850
Water Absorption	Arizona Test Method 210	0 – 2.5%



**404-3 Construction Requirements:**

**404-3.01 Weather Limitations:**

Bituminous material used in chip seal coats shall be applied to an existing bituminous surface only between the dates shown in Subsection 404-3.14 for the average elevation of the project, when the existing bituminous surface is dry, the pavement 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.

Bituminous material used in prime coats shall normally be applied to an existing aggregate surface only when the ambient air temperature in the shade is at least 70 degrees F and when the existing aggregate surface is slightly damp.

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.

**404-3.02 Equipment:**

**(A) Distributor Truck:**

Distributor trucks shall be so designed, equipped, maintained and operated that bituminous material at even heat may be applied uniformly on variable widths of surface at readily determined and controlled rates of 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 from the date of spreading. However, the Engineer may at any time require that each distributor truck be tested to determine the rate of the transverse spread.

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 type equipped, maintained and operated so that the bristles are of reasonably uniform length and capable of cleaning without gouging or tearing the surface.

**(C) Rollers:**

Rollers shall be of the oscillating type having a width of not less than four 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. The tires shall be inflated to 90 pounds per square inch, or such lower pressure as designated by the Engineer, and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure. Pneumatic-tired rollers shall be 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. The total operating weight of the roller shall be varied as directed by the Engineer.

**(D) Aggregate Spreaders:**

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 and capable of applying aggregate uniformly across the spread width.

The application of blotter material shall be accomplished by means of a sand slinger or other equipment approved by the Engineer.

Aggregate application rates are expected to vary from four to 40 pounds per square yard, depending on the type of construction.

**404-3.03 Traffic Control:**

In the construction or application of a bituminous treatment, the treated roadway surface shall not be used by the contractor, its agents, or others 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 application until approved by the Engineer. The contractor shall erect and maintain approved barricades, signs and other traffic control devices and shall use every possible means to protect the work and to exclude traffic from the roadway surface for as long a time as may be required. Traffic shall be handled in the manner most convenient to the traveling public. When traffic is handled on a one-way basis, the contractor shall provide such flaggers and pilot trucks as deemed necessary to insure adequate protection for the roadway surface. Traffic may be detoured around the work, provided that detours are constructed and maintained in a satisfactory manner and properly signed. When it is necessary to provide for traffic across

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a bituminous treated surface, the crossing shall be blotted with material, as directed, before the crossing is opened to traffic.

### **404-3.04 Preparation of the Surface:**

The surface to be treated shall be thoroughly cleaned to the satisfaction of the Engineer prior to applying the bituminous material.

When the work consists of a chip seal coat or when blotter material is applied, self-propelled rotary power brooms along with hand brooms, if necessary, 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. Any 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 surface conforming to the adjacent area. Uniformity of surface texture is of the utmost importance.

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 will be as specified herein.

The Engineer will specify the exact rates based on the surface to be treated and the characteristics of the aggregate material. The rates to be applied may vary substantially because of different surface conditions within the project limits. The actual bituminous material application shall not vary more than 10 percent from the application rate specified by the Engineer.

The bituminous material shall be uniformly applied to the prepared surface at the rate specified by the Engineer and in one application.

The various types or grades of bituminous materials shall be mixed with materials or 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 whatever, 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 unnecessary delay as directed by the Engineer.

Care shall be taken to prevent the spraying or splattering of bituminous material on adjacent pavements, structures, curb, guardrail, trees and shrubbery or any other object outside of the area designated for spraying.

Unused bituminous material shall not be disposed of within the right-of-way lines.

#### **404-3.06 Application of Cover Material:**

Cover material shall be immediately and uniformly spread over the freshly applied bituminous material. 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 wet but free of running water at the time of spreading. When bituminous material other than emulsified asphalt is used, the cover material, at the time of spreading, shall be at least as dry as the material dried to a saturated surface-dry condition in accordance with the requirements of Arizona Test Method 210.

#### **404-3.07 Rolling Cover Material:**

Following the spreading of cover material, the surface shall be promptly rolled with self-propelled pneumatic-tired compactors. A sufficient number of compactors shall be provided to cover the width of the material spread in one pass of the compactors and this rolling shall continue until a minimum of three passes has been completed.

#### **404-3.08 Removing of Loose Cover Material:**

All loose cover material shall be removed from the paved surface by brooming in not less than 12 hours nor more than 36 hours after application; however, if because of weather conditions, temperature or

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other reasons, 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. 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.

### **404-3.09            Application of Blotter Material:**

The approximate amount of blotter material, when required as a part of a bituminous treatment, will be specified in the Special Provisions; however, the Engineer will specify the exact rate to be applied based on the characteristics of the bituminous treated surface.

Blotter material, at the time of spreading, shall be wet but free from running water.

Blotter material shall be uniformly spread. Any oversize 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. The method of removal and the disposal of any excess blotter material shall be the contractor's responsibility.

### **404-3.10            Joints:**

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 butt joints.

Joints shall be cleaned as deemed necessary by the Engineer prior to the application of bituminous material in the adjacent strip.

Regardless of the width of the roadway to be sealed, the number of longitudinal joints shall be kept to a minimum and shall be located to the greatest degree possible so that they will coincide with painted lines between traffic lanes.

### **404-3.11            Prime Coat:**

The type of bituminous material and the approximate application rate shall be as specified in the Special Provisions.

When it is deemed necessary, areas having excess bituminous material shall be blotted with material as directed.

When so directed, 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 satisfactorily repaired by the contractor.

#### **404-3.12 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 layers of bituminous mixtures.

The material to be used for bituminous tack coat will be specified by the Engineer and shall conform to the requirements of Section 1005.

The type, grade or designation, and the rate of application for the specific usage will be specified by the Engineer. The following table shows the various types of material from which the Engineer may select the tack coat and the approximate application rates:

Type, Grade or Designation	Approximate Application Rates: Gallons / Square Yard		Payment Factor
	Prior to Placing ACFC, AR-ACFC, or AR-AC	All Other Tack Coats	
Emulsified Asphalt (Special Type)		0.12	0.7
Emulsified Asphalt (Other than Special Type)		0.08	1.0
Asphalt Cement (Grade Specified by Engineer )	0.06 to 0.08	0.06	1.0

If emulsified asphalt of any designation or type is used, it shall have broken before asphaltic concrete is placed.

If emulsified asphalt of any designation or type is held over night, it shall be reheated and agitated prior to further application.

The Engineer may either reduce the rate to be applied or, except as specified below, eliminate the use of tack coat in any part of the work if, in the Engineer's judgment, the bituminous mixture to be placed will be effectively bonded to the underlying surface. For asphaltic concrete friction course, asphaltic concrete friction course (asphalt-rubber), or

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asphaltic concrete (asphalt-rubber), application of asphalt cement tack coat immediately prior to placing such pavements shall not be eliminated, although the Engineer may adjust the application rate within the above stated limits.

Bituminous material shall be applied only as far in advance of the placement of the bituminous mixed materials as is necessary to obtain the proper condition of tackiness. In no event shall more bituminous material be applied in one day than will be covered by bituminous mixed materials during that same day.

**404-3.13            Fog Coat:**

The type of bituminous material and the approximate application rate shall be as specified in the Special Provisions. The material shall be diluted with one part water to one part bituminous material.

Blotter material shall be applied to the treated surface in one or more applications for a total application as specified in the Special Provisions at a time specified by the Engineer and before opening to traffic.

**404-3.14            Chip Seal Coat:**

The design quantities of cover material and bituminous material for chip seal coat shall be determined in accordance with Arizona Test Method 819.

The type of bituminous material shall be CRS-2. The approximate application rate shall be as specified in the Special Provisions.

Cover material shall be applied at the rate of approximately 0.01 cubic yards per square yard; however, the Engineer will specify the exact rate to be applied based on the characteristics of the aggregate material and the surface to be treated.

The contractor shall submit a minimum 75-pound sample of cover material to the Engineer at least 10 calendar days prior to beginning application of the cover material for testing.

Chip seal coat shall be placed between the dates shown 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	May 1 – September 30
5000 and over	June 1 – August 31

The minimum traffic-free period for a newly applied chip seal coat shall be three hours; however, the contractor's hauling equipment may use the new seal coat during the traffic free period at a speed not to exceed 15 miles per hour. After the traffic free period, but prior to removing the loose cover material, all traffic allowed by the Engineer shall be limited to a speed not to exceed 25 miles per hour.

#### **404-4 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, when specified, will be measured by the cubic yard. Cover material will be weighed, 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 yard will be determined in accordance with the requirements of AASHTO T 19.

The contractor shall be responsible to determine the amount of cover material that will be required to complete the work from the source or sources from which the cover material is obtained.

Blotter material, when required, will be measured by the ton.

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 these specifications.

Time to apply tack 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 tack 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 workday, the time will be measured as four hours.

#### **404-5 Basis of Payment:**

The accepted quantities of bituminous treatments, complete in place, measured as provided above, will be paid for at the contract unit price, except the contract unit price for bituminous material will be adjusted for quantities of material represented by the corresponding test results. Adjustments will be made in accordance with Table 1005.



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Payment for all measures necessary to direct and escort traffic through the area being bituminous treated will be made as specified under Section 701.

No measurement or direct payment will be made for rolling.

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.

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 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 404-3.12, 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.

## SECTION 405 ROAD MIX BITUMINOUS PAVEMENT:

### 405-1 Description:

The work under this section shall include furnishing all materials and placing an aggregate material combined with a bituminous material, mixed and placed by the road mix method, to form a base or surface course or for other specified purposes in accordance with the details shown on the project plans and the requirements of these specifications.

### 405-2 Materials:

Aggregate shall conform to the requirements specified in the Special Provisions.

Bituminous material shall be liquid asphalt conforming to the requirements of Section 1005 for the grade specified in the Special Provisions.

### **405-3 Construction Requirements:**

#### **405-3.01 General:**

Prior to placing road mix bituminous pavement over an existing bituminous surface or a primed base all loose dirt and other objectionable material shall be removed from the existing surface. If so directed, such cleaning shall be done with a rotary power broom.

Prior to placing road mix bituminous pavement over a base course the base surface shall be smooth and firm and in reasonably close conformity to the lines, grades and dimensions required and shall be so maintained throughout the period of placing the road mix bituminous pavement.

#### **405-3.02 Placing Aggregate:**

Aggregate shall be deposited upon the prepared base or existing pavement and shaped into uniform windrows or shall be uniformly spread by an approved spreading device in the amount necessary to provide a surface of the required width and thickness.

When a traveling mixing plant is used, the loose material shall be placed in windrows or in a blanket of uniform cross section and of such size that all the material in the windrow or blanket can be passed through the mixing plant at each mixing operation.

#### **405-3.03 Application of Bituminous Material:**

Bituminous material shall be applied to the aggregate at a temperature conforming to the range of temperatures specified in Table 1005-6.

Bituminous material shall be applied only when the atmospheric temperature in the shade is above 70 degrees F.

Application of bituminous material shall not be made when the aggregate contains more than 1.5 percent moisture; however, in special cases when the aggregate is unusually porous, a moisture content in excess of 1.5 percent may be permitted at the discretion of the Engineer.

The approximate amount of bituminous material to be used will be specified in the Special Provisions; however, the exact amount will be determined by the Engineer at the time of application.

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The total bituminous material required shall be applied to the aggregate uniformly in two or more applications. Application shall conform to the requirements of Section 404.

### **405-3.04        Mixing:**

#### **(A)        General Requirements:**

The aggregate and the bituminous material shall be mixed by means of a motor grader or shall be mixed by means of a traveling mixing plant, supplemented by motor grader mixing, if necessary. During the mixing operations care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter.

Should the mixture show an excess, deficiency or uneven distribution of bituminous material, the condition shall be corrected by the addition of aggregate or bituminous material as required and remixing.

#### **(B)        Motor Grader Mixing:**

Immediately following each application of bituminous material, sufficient mixing shall be done to absorb partially the bituminous material and prevent the formation of pools. After the final quantity of bituminous material has been applied and the materials partially mixed, the entire volume of loose material shall be moved into a windrow in the center or side of the road. The windrow shall then be processed until all particles of the mixture are thoroughly and uniformly coated with bituminous material. During this operation the blade shall be set so as to cause a revolving motion of the mixture. The amount of mixing required will be determined on the basis of uniform color and consistency of the mixture.

#### **(C)        Traveling Plant Mixing:**

The plant used for mixing shall be so constructed that it will readily and cleanly pick up all the aggregate without damage to the base and will feed the aggregate to the mixing chamber at a uniform rate. The bituminous material feed shall be readily adjustable and be mechanically synchronized with the flow of aggregate to the mixer. Manual controls of the flow of bituminous material will not be permitted. Each time mixing commences or ends, the starting or stopping of the bituminous material application shall be so timed as to avoid the formation of rich or lean spots in the mixture.

The materials shall be mixed until a uniform product is obtained with all particles of aggregate thoroughly coated with bituminous material.

### **405-3.05        Spreading:**

The mixture shall be thoroughly aerated before spreading in order to reduce the solvents.

The completely mixed material shall be spread only by skilled operators. Spread lengths shall be limited in order that the finishing and compacting can be completed within the same day. The motor grader used to spread the mixture shall have a blade not less than 12 feet long, and a wheel base of not less than 16 feet, and shall be free from lost motion in the blade control. After spreading on the road bed, if necessary, the moisture content shall be reduced by blading and reblading the mixture and allowing it to dry before final spreading.

If the thickness of the material to be compacted is greater than two inches after spreading as specified above, approximately the upper one half of the material shall be removed and placed in windrows of equal size on each side. The windrows shall be so placed that earth or shoulder material will not become mixed with the windrowed material. The area between the windrows shall then be thoroughly rolled with pneumatic-tired rollers, after which the windrows shall be moved and the areas occupied by the windrows shall be rolled. Then the windrowed material shall be evenly spread over the lower compacted layer and shall be shaped and rolled to the finished grade and cross section.

Other methods of spreading the material may be used if approved by the Engineer.

#### **405-3.06      Compacting:**

Compacting equipment shall consist of pneumatic tired-compactors and tandem power (steel wheel) compactors. Compactors shall be self-propelled.

The position of the seat or seats or the placement of the mirrors shall be such as to enable the operator to have the edge of the pavement against which the bituminous road mix is being compacted in the operator's full view at all times.

At its option, the contractor may furnish either pneumatic-tired compactors of the type that are equipped with means for increasing or decreasing the air pressure in the tires while in operation or compactors of the conventional type.

Pneumatic tired compactors shall be designed so that they are capable of turning or reversing direction on the bituminous road mix surfaces without scuffing or displacing the material.

Steel wheel compactors shall weigh not less than eight tons and shall be rated according to the manufacturer's rating in tons.

Sufficient rolling equipment shall be furnished to compact and finish satisfactorily the amount of mixture being placed.

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Rolling with pneumatic-tired rollers shall be continuous throughout the spreading operations.

Tandem power rollers shall be used for final compaction and finish rolling.

Final rolling shall be done longitudinally, beginning at the outer edge and progressing toward the center, except that on superelevated curves the Engineer may require that rolling progress from the lower to the upper edge. Under no circumstances shall the center of the road be rolled first.

Each passage of the roller shall overlap the preceding passage not less than one half the width of the roller. Rolling shall continue until the surface is smooth and uniformly and thoroughly compacted.

### **405-3.07 Surface Requirements and Tolerances:**

An acceptable surface shall not vary more than 3/16 inch from the lower edge of a 10-foot straightedge when the straightedge is placed parallel to the center line of the roadway.

When deviations in excess of the above tolerances are found, such places, as humps or depressions, shall be corrected.

### **405-3.08 Inaccessible Areas:**

At locations where bituminous road mix is to be placed over areas inaccessible to conventional mixing, spreading or compacting equipment, the material may be mixed at other locations and spread and compacted by other approved methods.

### **405-4 Method of Measurement:**

Road mix bituminous pavement will be measured by the ton for the mixture actually used, which will include the weight of aggregate and bituminous material. Measurement will include any weight used to construct intersections, turnouts, curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks or other miscellaneous items or surfaces.

Bituminous material of the type specified will be measured by the ton in accordance with the requirements of Section 109.

Measurement for payment will be made only of the quantity of bituminous material used in accordance with the requirements of these specifications.

### **405-5 Basis of Payment:**

The accepted quantities of road mix bituminous pavement, measured as provided above, will be paid for at the contract unit price per ton, which price shall be full compensation for the work complete in place, including compaction and necessary surface preparation.

Payment for bituminous material will be made by the ton. Adjustments in the contract unit price, in accordance with the requirements of Section 1005, will be made for the quantities of material represented by the corresponding test results.

## **SECTION 406 ASPHALTIC CONCRETE:**

### **406-1 Description:**

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling and placing mixture of aggregate materials, mineral admixture, and an 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 these specifications.

It is the intent of this specification that the contractor acquire and make all arrangements for a source or sources of material; that it furnish Certificates of Compliance as hereinafter specified; that it furnish a mix design which will meet the design criteria specified hereinafter; and that it provide all the equipment, materials, and labor necessary to furnish and place the asphaltic concrete in accordance with the requirements specified herein.

### **406-2 Asphaltic Concrete Mix Design Criteria:**

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:

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Criteria	Requirements		Arizona Test Method	
	3/4 inch Mix	Base Mix		
1. Voids in Mineral Aggregate: %, Range	15.0 – 18.0	14.5 - 17.0	815	
2. Effective Voids: %, Range	Note (1)	Note (1)	815	
3. Absorbed Asphalt: %, Range	0 - 1.0	0 - 1.0	815	
4. Index of Retained Strength: %, Min. (2)	60	60	802	
5. Wet Strength: psi, Minimum	150	150	802	
6. Stability: pounds, Minimum	2,000	3,000	815	
7. Flow: 0.01 inch, Range	8 – 16	8 – 16	815	
8. Mix Design Grading Limits:			201	
Sieve Size	Percent Passing			
	3/4 inch Mix		Base Mix	
	Without Admixture	With Admixture	Without Admixture	With Admixture
1-1/4 inch			100	100
1 inch	100	100	90 - 100	90 - 100
3/4 inch	90 - 100	90 - 100	85 - 95	85 - 95
3/8 inch	62 - 77	62 - 77	57 - 72	57 - 72
No. 8	37 - 46	38 - 47	32 - 42	33 - 43
No. 40	10 - 18	11 - 19	8 - 16	9 - 17
No. 200	1.5 - 4.5	2.5 - 6.0	1.5 - 3.5	2.5 - 5.0
Notes:				
(1) As specified in the Special Provisions.				
(2) For Interstate roadways, if the average elevation of the project is above 3,500 feet, the Index of Retained Strength shall be a minimum of 70 percent.				

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 specified in the Special Provisions.

**406-3 Materials:****406-3.01 Mineral Aggregate:**

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001-4.01 (B) shall not apply.

Coarse 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 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 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 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 aggregate up to a maximum of 15 percent of the total aggregate, provided that the composite of uncrushed fine aggregate and crushed fine aggregate meets the requirement for uncompacted void content. The uncrushed fine 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.

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.



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<b>Mineral Aggregate Characteristics</b>	<b>Test Method</b>	<b>Requirement</b>
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
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 85% with at least two fractured faces and minimum 92% with at least one fractured face (plus No. 4 material)
Uncompacted Void Content	Arizona Test Method 247	Minimum 45.0%
Carbonates (Only if the asphaltic concrete is the designed final pavement surface normally used by traffic; detours and temporary paving are excluded.)	Arizona Test Method 238	Maximum 20%

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. Abrasion shall be performed separately on materials 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, according to the contractor's mix design proposal, for combined bulk specific gravity and/or combined water absorption up to a maximum of 3.0 percent but meets other specified requirements will be further considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement 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.

#### **406-3.02 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.

<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

#### **406-3.03 Bituminous Material:**

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. 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  $0.17 \pm 0.02$  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  $0.28 \pm 0.03$  Pascal-seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. 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 °F or a maximum laboratory compaction temperature exceeding 300 °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 compaction temperatures used, shall be reported on the mix design. The contractor shall ensure that the asphalt binder

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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 406-6 and 406-7.

### **406-4 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 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 under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. 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 the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009.

The contractor may purpose 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 asphalt cement and mineral admixture type and source of supply, 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 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. Any previously used mix design that is older than one year, but less than two years, shall not be allowed for use unless the contractor provides verification testing results. Such testing shall be one-point verification at the design asphalt content using the proposed mineral aggregate, asphalt cement, and mineral admixture. Once approved for use on a project, a mix design may be used for the duration of the project.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) 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.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture.
- (6) 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), 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.
- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

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 mineral aggregate, mineral admixture, and asphalt cement 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. 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.

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The sand equivalent, fractured coarse aggregate particles, and uncompacted void content shall meet the requirements specified in Subsection 406-3.01. 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 of material, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

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. The self-directed target change shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
GRADATION	
3/8 inch sieve	±2% from mix design target value
No. 8 sieve	±2% from mix design target value
No. 40 sieve	±1% from mix design target value
No. 200 sieve	None
Asphalt Cement 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.

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.

406-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C). 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.
- (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 Asphaltic Concrete			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176	Crusher Belt or Stockpile	1 per 2000 Tons of total aggregate (1)
Fractured Coarse Aggregate Particles	ARIZ 212		
Uncompacted Void Content	ARIZ 247		
Asphaltic Concrete			
Gradation	ARIZ 201 or 427	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1000 Tons
Asphalt Content	ARIZ 421, 427, or other approved methods	Roadway or Plant	1 per 1000 Tons
Voids	ARIZ 415, 417, 424	Roadway or Plant	1 per 1000 Tons each day. Maximum of 4 per day.
Compaction	ARIZ 412	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.			

#### **406-6 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 or mineral aggregate upon discharge from the drier shall not exceed 325 °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.

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 the work to cease or that the workday be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

Longitudinal joints of each course shall be staggered a minimum of one 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



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joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one 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.

A light coat of bituminous material shall be applied as directed 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 Arizona Test Method 406.

### **406-7 Acceptance:**

#### **406-7.01 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:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted Void Content
- Gradation
- Asphalt Cement Content
- Effective Voids
- Stability
- Compaction
- Smoothness

**406-7.02            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 406-3.01 and the running average of three sand equivalent tests is at least 90 percent and no single test is less than 80 percent of the sand equivalent result contained in the contractor's mix design.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 406-3.01.

The uncompacted void content shall meet the minimum requirements specified in Subsection 406-3.01. 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 options of submitting a revised mix design conforming to the requirements of Subsection 406-4 or correcting deficiencies in its aggregate stockpiles.

**406-7.03            Blank:**

**406-7.04            Gradation, Asphalt Cement Content, Effective Voids, and Stability:**

A lot shall be considered to be one shift's production. In the event a shift's production is less than 1200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more

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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 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 shall be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 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 asphalt cement content, gradation, Marshall density and stability, and maximum theoretical density. Asphalt cement content and gradation shall be tested in accordance with Arizona Test Method 427 using an ignition furnace. A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs. Marshall density and stability, and maximum theoretical density shall be tested in accordance with the requirements of Arizona Test Method 410 and 417 respectively. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424.

For plants providing asphaltic concrete exclusively for this project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined for the first five lots of asphalt concrete produced for each mix design. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, 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 there is a difference of greater than 0.1 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, the contractor may request that a correction to the asphalt cement content by ignition furnace testing shall 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 cement content, was made to the asphalt cement content by ignition furnace testing, referee testing shall not apply to the determination of asphalt cement 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. 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 cement 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.

In the event the contractor elects to question the test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for referee testing of that lot. The referee testing shall be performed in an independent approved laboratory designated by the Engineer. 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 tests results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for Marshall density and stability, and maximum theoretical density in accordance with the requirements of Arizona Test Method 410 and 417 respectively. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424. The samples shall also be tested in accordance with Arizona Test Method 427 for asphalt cement content by ignition furnace and gradation of the mineral aggregate. New PT's will be determined for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace test value was made as specified above. 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 results of these determinations will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the total pay factor of the lot does not improve or is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

A mixture properties lot placed with an average stability below 2500 pounds for base mixes, or 1750 pounds for 3/4 inch mixes shall be rejected, and shall be subject to an engineering analysis of anticipated performance in accordance with Subsection 406-9(E). 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:

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Measured Characteristics	LL	UL
Gradation (sieve size):		
3/8 inch (see Note 2 below)	TV - 6.0	TV + 6.0
No. 8	TV - 6.0	TV + 6.0
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 + 1.5
<b>Notes:</b> (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).  (2) In the case of 3/8 inch sieve requirement, for the base mix only, the lower limit shall be the target value minus 8.0, and the upper limit shall be the target value plus 8.0.		

The Engineer will determine the PT of each measured characteristic in accordance with Subsection 406-9(l) and, utilizing Table 406-1, will determine pay factors for each measured characteristic.

### 406-7.05 Compaction

#### (A) Courses 1-1/2 inch 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.

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250 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.

##### (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 eight 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
<b>Initial</b>	Static Steel	Vibrating Steel	1	1
<b>Intermediate</b>	Pneumatic Tired	Vibrating Steel	4	2 - 4*
<b>Finish</b>	Static Steel	Static Steel	1 - 3	1 - 3
* 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 one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 °F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 °F.

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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 inch in Nominal Thickness:**

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractors 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 lot for compaction purposes shall be identical to the lot described in Subsection 406-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 406-9(D). 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 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 one-half foot in the transverse direction and to the nearest one foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. Areas excluded from testing will be compacted in accordance with Subsection 406-7.05(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after the lot or subplot placement. The cores shall be delivered to the Engineer immediately upon being taken. The cores will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing 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 7.0 percent in-place air voids. In-place air voids shall be determined using Arizona Test Method 424.

The maximum theoretical density used in determination of air voids will be the average of the four maximum theoretical densities determined in Subsection 406-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 4.0 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 406-9(I), and utilizing Table 406-1 will determine the compaction pay factor.

In the event the contractor elects to question the core test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for referee testing of that lot. The cores previously saved will be tested in accordance with the requirements of Arizona Test Method 415 in an independent testing laboratory designated by the Engineer. 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, the test results by the Department, or the density target. Using the referee test results, the Engineer will determine a new PT for compaction. The result of this determination will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the compaction pay factor of the lot does not improve, is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

#### **406-7.06 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.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) 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 ten-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.
- (2) 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 ten-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.



- (3) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

**406-8 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.

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsection 406-7.04 for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results, unless a correction, based on the actual asphalt cement content, was made to the ignition furnace test value as allowed in Subsection 406-7.04. If a correction, based on the actual asphalt cement content, was made to the ignition furnace test value, the average asphalt cement content determined from the Department's acceptance testing will be used. At the discretion of the Engineer, asphalt cement may be measured by invoice quantities, adjusted as necessary for waste. In no case shall the measured amount of asphalt cement 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 406-6.

**406-9 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 total pay factor as hereinafter provided.

For the purpose of determining acceptability and appropriate total pay factors, each unit of asphaltic concrete will be included in two separate lots: 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 mixture properties lot pay factor and compaction lot pay factor.

The Engineer may exclude certain locations from the mixture properties lot quantity and/or the compaction lot quantity 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) Blank**

**(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 406-7.04.
- (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 406-9(E) shall apply.

**(C) Compaction Lot Pay Factor:**

The compaction lot pay factor shall be the compaction pay factor determined as set forth in Subsection 406-7.05(B).

**(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 mixture properties lot pay factor and compaction lot pay factor for each project shall be determined as follows:

- (1) 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 406-7.04, regardless of which project(s) the samples fall within.
- (2) PT values and pay factors for compaction, for those areas subject to Subsection 406-7.05(B), shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that subsection.
- (3) The mixture properties lot pay factor shall be determined separately for each project in accordance with

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Subsection 406-9(B), utilizing the individual pay factors determined in (1) above.

- (4) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 406-9(C), utilizing the pay factor determined in (2) 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 15 days after receiving notice that a mixture properties lot or a 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 \$5.00 per ton each for mixture properties lots and compaction lots. 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. Positive compaction lot pay factors become zero when the mixture properties lot is in reject and the material is allowed to remain 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).

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 a professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected 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.

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 factors, 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.
- (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 406-4, 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:**

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

**(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.

**(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 406-1 with PT.

<b>TABLE 406-1</b>			
<b>MIXTURE PROPERTIES AND COMPACTION PAY FACTORS</b>			
<b>PT</b>	<b>Pay Factors (Dollars per Ton)</b>		
	<b>Gradation and Asphalt Content</b>	<b>Effective Voids</b>	<b>Compaction</b>
100	0.00	+1.00	+1.00
95-99	0.00	+0.50	+0.50
90-94	0.00	0.00	0.00
85-89	0.00	-0.25	-0.25
80-84	-0.25	-0.50	-0.50
75-79	-0.50	-0.75	-0.75
70-74	-0.75	-1.00	-1.00
65-69	-1.00	-1.25	-1.30
60-64	-1.50	-1.50	-1.75
55-59	-2.00	-2.00	-2.25
50-54	-2.50	-2.50	-3.00
Less Than 50	Reject – See Subsection 406-9(E)		

**SECTION 407 ASPHALTIC CONCRETE FRICTION COURSE:****407-1 Description:**

Asphaltic Concrete Friction Course (hereinafter asphaltic concrete) shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of an aggregate material, mineral admixture, and a bituminous material 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 these 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:****407-3.01 Mineral Aggregate:**

There is no Department-furnished source of mineral aggregate. The contractor shall provide a source 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 three 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 Arizona Test Method 201.

<b>TABLE 407-1 MIX DESIGN GRADING LIMITS</b>		
<b>Sieve Size</b>	<b>Percent Passing</b>	
	<b>Without Admixture</b>	<b>With Admixture</b>
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**

<b>Characteristic</b>	<b>Test Method</b>	<b>Requirement</b>
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	Arizona Test Method 242 (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	Arizona Test Method 212	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**

<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

#### **407-3.03 Bituminous Material:**

Asphalt cement shall be an asphalt binder performance grade PG 64-16, conforming to the requirements of Section 1005.

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: one gallon of asphalt cement from the intended supplier, and a one-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, 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.

#### **407-5                    Mix Design Revisions:**



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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 changes are made in the source or type of bituminous material or the source(s) of mineral aggregate, or changes are made in the proportions of mineral aggregate equal to or greater than five percentage points, additional 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, Removal of Unacceptable and Unauthorized Work.

If the production of asphaltic concrete is stopped either for failure to meet the requirements specified in Subsection 407-6.03 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. 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 3-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 Arizona Test Method 105 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

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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 Arizona Test Method 201.

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	
	3 Consecutive	One
No. 4	$\pm 4$	$\pm 6$
No. 8	$\pm 4$	$\pm 6$
No. 200	$\pm 1.5$	$\pm 2.0$

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 3-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 Arizona Test Method 421. 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 the Department's System for the Evaluation of Testing Laboratories. The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, AZ 85009.

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  $\pm 0.60$ , or the average of three consecutive test results varies by an amount greater than  $\pm 0.40$ , 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  $\pm 0.61$  to  $\pm 0.75$ , 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  $\pm 0.75$  from the amount directed by the Engineer unless, by retesting, the material is found to be acceptable.

#### **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 three percent of the total mineral aggregate.

Changes in stockpile or hot bin use in excess of five percent from the approved mix design will not be permitted without the approval of the Engineer.

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 Arizona Test Method 406.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the dryer shall not exceed 240 degrees F.

##### **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 and other equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material and tacked with asphalt cement in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the amount and grade of asphalt cement used shall be as directed by and acceptable to the Engineer.

Unless otherwise specified on the project plans, asphaltic concrete shall not be placed on the two-foot widened section where guardrail is to be installed.

**(1) Placement Dates and Weather Requirements:**

Asphaltic concrete shall be placed only between the dates shown below for the average elevation of the project, and only 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 65 degrees F and rising. The placement shall be stopped when the ambient temperature is 70 degrees F or less and falling.

Average Elevation of Project, Feet	Beginning and Ending Dates
0 – 3499	March 15 – May 31
0 – 3499	September 15 – October 31
3500 – 4999	April 15 – October 15
5000 and over	June 1 – September 15

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 up to three applications 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.

## **(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 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.
- (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 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.

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Self-propelled paving machines shall spread the mixture without segregation or tearing within the specified tolerances, 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 eight feet in width, or widened sections not exceeding four 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:

Ski-type device at least 30 feet in length, supported throughout its entire length.

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 one 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 one 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.

##### **(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 eight 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:

<b>Rolling Sequence</b>	<b>Number of Coverages</b>
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.



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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.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) The finished asphaltic concrete surface shall be tested and shall not vary by more than 1/8 inch from the lower edge of a ten-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.
- (2) 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.

Asphalt cement will be measured by the ton.

Mineral admixture will be measured by the ton.

#### **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, which price shall be full compensation for the work, complete in place, as specified herein.

Payment for asphalt cement will be made by the ton. The results of a nuclear asphalt content gauge shall not be used to determine the weight of asphalt cement as the basis of payment. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

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.

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.

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#### **SECTION 409 ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL):**

##### **409-1 Description:**

Asphaltic concrete shall consist of furnishing all materials, mixing, hauling, and placing a mixture of aggregates, mineral admixture, and bituminous material to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and as directed by the Engineer.

The contractor may propose the use of a mix design that has been developed for a previous project. The contractor shall provide evidence that the asphalt cement and mineral admixture type and source of supply, 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

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characteristics of the mineral aggregate proposed for use. The Engineer will determine if the previously used mix design is suitable for the intended use. 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. Any previously used mix design that is older than one year, but less than two years, shall not be allowed for use unless the contractor provides verification testing results. Such testing shall be a one-point verification at the design asphalt content utilizing the proposed mineral aggregate, asphalt cement, and mineral admixture. Once approved for use on a project, a mix design may be used for the duration of the project.

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 - 2.5%
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	Arizona Test Method 212	Minimum 70% (plus No. 4 material)

The gradation will be determined in accordance with Arizona Test Method 201, and shall conform to the requirements given below.

Mix Design Grading Limits				
Sieve Size	Percent Passing			
	Lift Thickness Less Than or Equal to Two Inches		Lift Thickness Greater Than Two Inches	
	Without Admixture	With Admixture	Without Admixture	With Admixture
1 Inch			100	100
3/4 Inch	100	100	90 - 100	90 - 100
1/2 Inch	90 - 100	90 - 100	---	---
3/8 Inch	70 - 85	70 - 85	70 - 85	70 - 85
No. 8	41 - 51	42 - 52	41 - 51	42 - 52
No. 200	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. 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  $0.17 \pm 0.02$  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  $0.28 \pm 0.03$  Pascal-seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. 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 °F or a maximum laboratory compaction temperature exceeding 300 °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.

#### 409-2.03 Mineral Admixture:

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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 C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

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 psi when tested in accordance with Arizona Test Method 802.

A Certificate of Analysis conforming to the requirements of Subsection 106.05 of the Standard Specifications shall be submitted.

### **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.

The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. 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 the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009.

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	815
2. Effective Voids: %, Range	5.5 - 6.5	815
3. Absorbed Asphalt: %, Range	0-1.0	815

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. The Engineer may waive the requirements for a mix design if the intended use of the material is temporary in nature.

#### **409-2.05 Sampling and Testing:**

Sampling and testing the materials or mixture for quality control purposes shall be the contractor's responsibility. 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 smoothness requirements shall be met:

- (1) 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 ten-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.
- (2) 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 ten-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.

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- (3) 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 Arizona Test Method 406.

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 and other equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250 degrees F.

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.

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.

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 objectionable material and tacked in accordance with the requirements of Subsection 404-3.12.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course. Longitudinal joints shall be located within one foot of the center of a lane or within one 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		Number of Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
<b>Initial</b>	Static Steel	Vibrating Steel	1	1
<b>Intermediate</b>	Pneumatic Tired	Vibrating Steel	2 – 6*	2 - 4*
<b>Finish</b>	Static Steel	Static Steel	1 - 3	1 - 3

\* Based on the roller pattern which exhibits the best performance.



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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 one 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 eight 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 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 and the following formula:

$$R = (100 - P) \times \left[ \frac{(\$200) \times (T)}{100} \right]$$

Where:

- R = Amount of Reduction in Payment (dollars)
- T = Quantity of asphalt cement in failure (tons, rounded to nearest tenth)
- P = Percent of Contract Unit Price allowed (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 these specifications.

#### **410-2 Materials:**

##### **410-2.01 Tack Coat:**

The existing roadway surface upon which the Asphalt Rubber Membrane is to be placed, shall be first cleaned of potentially detrimental material and tacked with a light coat of bituminous material, conforming to the requirements of Subsection 404-3.12 of the specifications. The cleaning of the surface, the tacking of the surface and the type and amount of bituminous material used shall be as directed by the Engineer.

##### **410-2.02 Asphalt-Rubber:**

Asphalt-Rubber shall conform to the requirements of Section 1009. 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.

##### **410-2.03 Cover Material:**

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Cover material shall conform to the requirements of Subsection 404-2.02(C).

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.

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:

- (1) The pavement surface temperature is above 75 degrees F.
- (2) The pavement is dry.
- (3) The wind conditions are such that a satisfactory membrane can be achieved.
- (4) 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)

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  $0.55 \pm 0.05$  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 four 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 404-3.06.

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.

Cover material shall be precoated with 0.40 to 0.60 percent asphalt cement, by weight of the aggregate. The cover material shall have a minimum temperature of 250 degrees F at the time of precoating with asphalt cement. The asphalt cement shall meet the requirements of Section 1005. The end result shall be a dust free material.

#### **410-3.04            Rolling:**

At least three pneumatic rollers shall be provided to accomplish the required rolling. The rollers shall conform to the requirements of Subsection 406-7.05 (A) (2), except that the minimum air pressure in each tire shall be 100 pounds per square inch.

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:

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Existing Pavement Temperature	Complete Rolling Within
100 °F and above	20 Minutes
Between 65 and 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 404-3.08. 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.

### **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 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.

The quantities of bituminous tack coat and time to apply tack coat will be measured in accordance with the requirements of Section 404.

### **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.

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:**

Asphaltic Concrete Friction Course, hereinafter asphaltic concrete, shall consist of furnishing all materials, mixing, hauling and placing a mixture of aggregates, mineral admixture, and bituminous material to form a pavement course in accordance with the details shown on the project plans and as directed by the Engineer.

### **411-2 Materials:**

#### **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 three 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.

<b>Mineral Aggregate Characteristics</b>	<b>Test Method</b>	<b>Requirement</b>
Abrasion	AASHTO T 96	100 Rev., Max 9 % 500 Rev., Max 40%
Sand Equivalent	Arizona Test Method 242 (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	Arizona Test Method 212	Minimum 85% (at least two fractured faces) and minimum 92% (at least one fractured face)
Flakiness Index	Arizona Test Method 233	Maximum 25%

The gradation will be determined in accordance with Arizona Test Method 201, and shall conform to the requirements given below.

<b>Sieve Size</b>	<b>Percent Passing</b>	
	<b>Without Mineral Admixture</b>	<b>With Mineral Admixture</b>
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:

<b>MINERAL ADMIXTURE</b>	
<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

#### **411-2.03 Bituminous Material:**

Asphalt cement shall be an asphalt binder performance grade PG 64-16, conforming to the requirements of Section 1005.

Approximately six percent will be required; however, the exact amount 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 or mixture for quality control purposes shall be the contractor's responsibility. 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.

The surface upon which the asphaltic concrete is to be placed shall be cleaned of all objectionable material and tacked with a light coat of asphalt cement. The cleaning of the surface, the tacking of the surface and the grade and amount of asphalt cement used shall be as directed by and acceptable to 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.



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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 eight 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 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 that do not meet the requirements of Section 1005 as determined by corresponding test

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results. Adjustments in payment will be made in accordance with the requirements of Table 1005-1 and the following formula.

$$R = (100 - P) \times \left[ \frac{(\$200) \times (T)}{100} \right]$$

Where:

- R = Amount of Reduction in Payment (dollars)
- T = Quantity of asphalt cement in failure (tons, rounded to nearest tenth)
- P = Percent of Contract Unit Price allowed (Table 1005-1)

## 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 these 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.

#### 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 an asphalt cement conforming to the requirements of Section 1005. The grade to be used shall be PG 64-16 or PG 70-10 as directed by the Engineer. The use of cutback or emulsion asphalts will not be allowed.

#### 412-2.03 Blotter Material:

Blotter material shall meet the requirements of Subsection 404-2.02(B).

#### 412-2.04 Fabric Packaging, Handling and Storing:

The identification, packaging, handling and storing of the geotextile fabric shall be in accordance with ASTM D 4873. 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). 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) 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:**

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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 six inches. The asphalt binder shall be applied only as far in advance of the fabric installation as is appropriate to insure 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 three inches to insure full closure of the joint, but shall not exceed six inches. Transverse joints shall be lapped in the direction of paving to prevent edge pickup by the paver. Longitudinal joints shall be located in the same manner as normal pavement joints according to Subsection 406-6. 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 Asphalt Concrete:**

All areas where fabric has been placed shall be paved with asphaltic concrete during the same workshift. 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 asphalt 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

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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.

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 ASPHALTIC CONCRETE (ASPHALT-RUBBER):

### 413-1 Description:

Asphaltic Concrete (Asphalt-Rubber), hereinafter asphaltic concrete, shall consist of 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 these specifications, and as directed by the Engineer.

The contractor shall be responsible for all adjustments to its equipment necessary to properly accommodate the use of asphalt-rubber as a bituminous material.

### 413-2 Asphaltic Concrete Mix Design Criteria:

Mix designs will be performed in accordance with Arizona Test Method 815, modified as necessary for Asphaltic Concrete (Asphalt-Rubber). Mix designs shall meet the criteria in Table 413-1.

**TABLE 413-1  
ASPHALTIC CONCRETE MIX DESIGN CRITERIA**

Criteria	Requirement
1. Effective Voids: %, Range	5.5 ± 1.0
2. Voids in Mineral Aggregate: %, Min.	19.0
3. Absorbed Asphalt-Rubber: %, Range	0 - 1.0

**413-3 Materials:**

**413-3.01 Mineral Aggregate:**

There is no Department-furnished source of mineral aggregate. The contractor shall provide a source 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.

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 a 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 by the Department.

Mineral aggregate shall be separated into stockpiles by the contractor. No individual stockpile or hot bin usage shall be less than three percent of the total mineral aggregate. No individual stockpile shall be permitted to contain more than 6.0 percent passing the No. 200 sieve when tested in accordance with Arizona Test Method 201. If necessary, the contractor shall wash the mineral aggregate to meet this requirement.

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



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grading limits in Table 413-2, when tested in accordance with Arizona Test Method 201.

TABLE 413-2 MIX DESIGN GRADING LIMITS		
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

Mineral aggregate shall conform to the requirements in Table 413-3 when tested in accordance with the applicable test methods.

Tests on aggregates outlined in Table 413-3, 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 413-3  
MINERAL AGGREGATE CHARACTERISTICS**

<b>Characteristics</b>	<b>Test Method</b>	<b>Requirement</b>
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
Fractured Coarse Aggregate Particles	Arizona Test Method 212	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 (Only if the asphaltic concrete is the designed final pavement surface normally used by traffic; detours and temporary paving are excluded.)	Arizona Test Method 238	Maximum 20%

#### **413-3.02 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 413-4.

**TABLE 413-4  
MINERAL ADMIXTURE**

<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

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### **413-3.03 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.

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.

### **413-3.04 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. The blotter material shall be applied in one or more applications for a total application of two pounds per square yard. The Engineer may reduce or eliminate blotter material if deemed to be unnecessary.

### **413-4 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 five-pound sample of the crumb rubber proposed for use, one gallon of asphalt cement from the intended supplier, three gallons of the proposed mixture of asphalt and rubber, and a one-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 413-3.01, 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 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 production shall not begin until there is an approved mix design.

#### **413-5                    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 changes are made in the source or type of bituminous material or the source(s) of mineral aggregate, or changes are made in the proportions of mineral aggregate equal to or greater than five percentage points, additional 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.

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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-rubber content without compensation being made to the contractor involving additional operation costs.

### **413-6 Acceptance of Materials:**

#### **413-6.01 General:**

The contractor's attention is directed to the requirements of Subsection 105.13, Removal of Unacceptable and Unauthorized Work.

If the production of asphaltic concrete is stopped either for failure to meet the requirements specified in Subsection 413-6.03 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 413-6.03. The Engineer reserves the right to increase the frequency of sampling and testing upon the resumption of asphaltic concrete production.

#### **413-6.02 Mineral Aggregate:**

Aggregate shall be free of deleterious materials, clay balls, and adhering films or other materials 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 and fractured coarse aggregate particles. Samples shall be obtained from the cold feed belt prior to 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 outlined in Table 413-3 for sand equivalent and fractured coarse aggregate particles, operations shall cease and the contractor shall have the option of requesting a new mix design or correcting deficiencies in the aggregate stockpiles.

#### **413-6.03          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 3-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 Arizona Test Method 105 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 with the mix design gradation, with or without mineral admixture as appropriate, in accordance with the requirements of Arizona Test Method 201.

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	
	3 Consecutive	One
3/8 Inch and larger	± 4	± 6
No. 4	± 4	± 6
No. 8	± 3	± 5
No. 200	± 1.0	± 1.5

One hundred percent of the material shall pass the largest sieve size shown in Table 413-2.

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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 3-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 Arizona Test Method 421. 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 the Department's System for the Evaluation of Testing Laboratories. The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, AZ 85009.

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  $\pm 0.60$ , or the average of three consecutive test results varies by an amount greater than  $\pm 0.40$ , 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  $\pm 0.61$  to  $\pm 0.75$ , 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  $\pm 0.75$  from the amount directed by the Engineer unless, by retesting, the material is found to be acceptable.

### **413-7 Construction Requirements:**

#### **413-7.01 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.

#### **413-7.02 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.

#### **413-7.03            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 three percent of the total mineral aggregate.

Changes in stockpile or hot bin use in excess of five percent from the approved mix design will not be permitted without the approval of the Engineer.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless 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 Arizona Test Method 406.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the dryer shall not exceed 350 degrees F.

#### **413-7.04            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 equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with asphalt cement in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the amount and grade of asphalt cement used shall be as directed by and acceptable to the Engineer.

A light coat of asphalt cement shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.



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The base or subgrade upon which the asphaltic concrete is to be placed shall be prepared in accordance with the applicable requirement for the material involved and maintained in a smooth and firm condition until placement. Asphaltic concrete shall not be placed on a frozen or excessively wet base or subgrade.

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.

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 asphaltic concrete shall be placed either as a leveling course or as a surfacing course. Leveling courses are defined as courses placed for the primary purpose of raising an existing paved or unpaved surface to a smooth plane. Surfacing courses are defined as courses placed to serve either as the traffic surface or as a surface upon which a finishing course or seal coat is to be placed.

Thickness of leveling and surfacing courses will be shown on the project plans. No change in thickness will be allowed without the written approval of 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, 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 without segregation or tearing within the specified tolerances, 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 eight feet in width, or widened sections not exceeding four 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:

Ski-type device at least 30 feet in length, supported throughout its entire length.

Short ski.

500 feet of control line and stakes.

Joint matcher shoe.

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The control line shall be set and maintained taut by the contractor to the grade and alignment established by the Engineer.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

### **413-7.05            Joints:**

Longitudinal joints of each course shall be staggered a minimum of one 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 one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot lapped, and shall be compacted while the mixture is still hot.

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 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.

When surfacing courses are placed on ten-foot or wider shoulders that are to receive a rumble strip, any longitudinal joint between the shoulder and the travel lane shall be located at the travel lane edge of the rumble strip.

### **413-7.06            Compaction:**

#### **(A)            General Requirements:**

The temperature of asphaltic concrete just prior to compaction shall be at least 275 °F.

The wheels of compactors shall be wetted with water, or if necessary soapy water, or a product approved by the Engineer to prevent the asphaltic concrete from sticking to the steel wheels during rolling. 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:**

For courses greater than one inch in nominal thickness, a minimum of one static steel-wheel compactor and two vibratory steel-wheel compactors shall be provided; however, sufficient vibratory steel-wheel compactors shall be provided so that the drums of the compactors when staggered will cover the entire width of the paving machine.

For courses of one inch or less in nominal thickness, a minimum of three static steel-wheel compactors shall be provided; however, sufficient compactors must be provided so that the drums of the compactors when staggered will cover the entire width of the paving machine on the initial forward pass while a static compactor remains to complete final rolling. If the asphaltic concrete production rate exceeds 250 tons per hour, an additional static steel-wheel compactor shall be provided.

The compactors shall weigh not less than eight tons.

The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. Vibratory rollers shall be used in the mode required by the Engineer. Vibratory compactors shall not be used in the vibratory mode for courses of one inch or less in nominal thickness.

**(C) Rolling Procedure:**

Vibratory compactors shall be used for initial breakdown on courses greater than one inch in nominal thickness. Static steel wheel compactors, or vibratory compactors in the static mode, shall be used for initial breakdown on courses one inch or less in nominal thickness. Initial breakdown rollers shall be maintained no more than 300 feet behind the paving machine. The roller(s) for final compaction shall follow as closely behind the initial breakdown as practical, such that a uniformly smooth surface is achieved. As many passes as are possible shall be made with the compactors before the temperature of the asphaltic concrete falls below 220 °F.

All edges shall be compacted by methods approved by the Engineer, while the mixture is still hot.

**413-7.07 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.

**413-7.08 Smoothness and Surface Tolerances:**

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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.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) 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 ten-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.
- (2) 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 ten-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.
- (3) All deviations exceeding the specified tolerances above shall be corrected by the contractor, to the satisfaction of the Engineer.

### **413-7.09      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.

### **413-8            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 material 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.

**413-9 Basis of Payment:**

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton, which price shall be full compensation for the work, complete in place, as specified herein.

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.

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.

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 414 ASPHALTIC CONCRETE FRICTION COURSE  
(ASPHALT-RUBBER):**

**414-1 Description:**

Asphaltic Concrete Friction Course (Asphalt-Rubber), hereinafter asphaltic concrete, shall consist of 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 these specifications, and as directed by the Engineer.

The contractor shall be responsible for all adjustments to its equipment necessary to properly accommodate the use of asphalt-rubber as a bituminous material.

**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:**

**414-3.01                Mineral Aggregate:**

There is no Department-furnished source of mineral aggregate. The contractor shall provide a source 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 three 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 Arizona Test Method 201.

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**

<b>Characteristic</b>	<b>Test Method</b>	<b>Requirement</b>
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	Arizona Test Method 242 (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	Arizona Test Method 212	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**

<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

#### **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



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rubber gradation shall be Type B conforming to the requirements of Section 1009.

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 five-pound sample of the crumb rubber proposed for use, one gallon of asphalt cement from the intended supplier, three gallons of the proposed mixture of asphalt and rubber, and a one-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, 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 the developing of the approved mix design.

Asphaltic concrete friction course production shall not begin until there is an approved mix design.

#### **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 changes are made in the source or type of bituminous material or the source(s) of mineral aggregate, or changes are made in the proportions of mineral aggregate equal to or greater than five percentage points, additional 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

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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, 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 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. 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 3-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 Arizona Test Method 105 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 Arizona Test Method 201.

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	
	3 Consecutive	One
No. 4	$\pm 4$	$\pm 6$
No. 8	$\pm 3$	$\pm 4$
No. 200	$\pm 1.0$	$\pm 1.5$

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 3-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 Arizona Test Method 421. 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

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are taken. The contractor's technicians performing the testing, including the calibration of the nuclear gauge, shall meet the technician requirements given in the Department's System for the Evaluation of Testing Laboratories. The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, AZ 85009.

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  $\pm 0.60$ , or the average of three consecutive test results varies by an amount greater than  $\pm 0.40$ , 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  $\pm 0.61$  to  $\pm 0.75$ , 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  $\pm 0.75$  from the amount directed by the Engineer unless, by retesting, the material is found to be acceptable.

### **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 three percent of the total mineral aggregate.

Changes in stockpile or hot bin use in excess of five percent from the approved mix design will not be permitted without the approval of the Engineer.

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 Arizona Test Method 406.

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 equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with asphalt cement in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the amount and grade of asphalt cement used shall be as directed by and acceptable to the Engineer.

Unless otherwise specified on the project plans, asphaltic concrete shall not be placed on the two-foot widened section where guardrail is to be installed.

##### **(1) Placement Dates and Weather Requirements:**

Asphaltic concrete shall be placed between the dates shown below for the average elevation of the project, and only 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.

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

At any time, the Engineer may require that the work cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

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). 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.

**(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.
- (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 without segregation or tearing within the specified tolerances, 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 eight feet in width, or widened sections not exceeding four 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:



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Ski-type device at least 30 feet in length, supported throughout its entire length.

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 one 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 one 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 product approved by the Engineer to prevent the asphaltic concrete from sticking to the steel wheels during rolling. 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 eight 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:

<b>Rolling Sequence</b>	<b>Number of Coverages</b>
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.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

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- (1) The finished asphaltic concrete surface shall be tested and shall not vary by more than 1/8 inch from the lower edge of a ten-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.
- (2) 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.

### **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, which price shall be full compensation for the work, complete in place, as specified herein.

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.

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.

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 these specifications.

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	Arizona Test Method
1. Voids in Mineral Aggregate, %, Minimum	19.0	(See Note)
2. Effective Voids, %, Range	5.5 ± 0.5	(See Note)
3. Absorbed Asphalt-Rubber, %, Range	0 – 1.0	(See Note)
4. Mix Design Grading Limits	201	
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
Note: Draft Method for the Design of AR-AC Mixtures available from the ADOT Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009.		

**415-3                    Materials:**

**415-3.01            Mineral Aggregate Source:**

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001-4.01(B) 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 three 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 Arizona Test Method 201. 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**

<b>Characteristics</b>	<b>Test Method</b>	<b>Requirement</b>
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	Arizona Test Method 247	Minimum 45.0
Fractured Coarse Aggregate Particles	Arizona Test Method 212	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 (Only if the asphaltic concrete is the designed final pavement surface normally used by traffic; detours and temporary paving are excluded.)	Arizona Test Method 238	Maximum 20%

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%), 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.

<b>TABLE 415-3 MINERAL ADMIXTURE</b>	
<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydrated Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

#### **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 be Type B conforming to the requirements of Section 1009.

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. The blotter material shall be applied in one or more applications for a total application of two pounds per square yard. The Engineer may reduce or eliminate blotter material if deemed to be unnecessary.

#### **415-4 Mix Design:**



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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 under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. 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 the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009.

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 asphalt-rubber and mineral admixture type and source of supply, 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 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. Any previously used mix design that is older than one year, but less than two years, shall not be allowed for use unless the contractor provides verification testing results. Such testing shall be a one-point verification at the design asphalt-rubber content using the proposed mineral aggregate, asphalt-rubber, and mineral admixture. Once approved for use on a project, a mix design may be used for the duration of the project.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.

- (3) 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.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture.
- (6) 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 mineral aggregate, mineral admixture, and asphalt-rubber 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. 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. Additional testing of the fine aggregate for uncompacted void content will be required if the method of producing fine aggregate is modified.

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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 of material, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

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. The self-directed target change shall meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation 3/8-inch sieve No. 4 sieve No. 8 sieve No. 200 sieve	$\pm 2\%$ from mix design target value $\pm 2\%$ from mix design target value $\pm 2\%$ from mix design target value None
Asphalt-Rubber Content	$\pm 0.2\%$ 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.

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). 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.
- (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:

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CONTRACTOR QUALITY CONTROL TESTING REQUIREMENTS			
TYPE OF TEST	TEST METHOD	SAMPLING POINT	MINIMUM TESTING FREQUENCY
Mineral Aggregate for Asphalt Concrete			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176	Crusher Belt or Stockpile	1 per 2000 Tons of total aggregate (1)
Fractured Coarse Aggregate Particles	ARIZ 212		
Uncompacted Void Content	ARIZ 247		
Asphaltic Concrete End-Product			
Gradation	ARIZ 201 or 427	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1000 Tons
Asphalt-Rubber Content	ARIZ 421, 427, or other approved methods	Roadway or Plant	1 per 1000 Tons
Voids	ARIZ 415, 417, 424	Roadway or Plant	1 per 1000 Tons each day. Maximum of 4 per day.
Compaction	ARIZ 412	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.

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 and other equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Longitudinal joints of each course shall be staggered a minimum of one 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 one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes.

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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 with asphalt cement in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the amount and grade of asphalt cement used shall be as directed by and acceptable to the Engineer.

A light coat of asphalt cement shall be applied as directed 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 Arizona Test Method 406.

**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:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted Void Content
- Gradation
- Asphalt-Rubber Content
- Effective Voids
- Material Spread
- Compaction
- 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 and the running average of three sand equivalent tests is at least 90 percent and no single test is less than 80 percent of the sand equivalent result contained in the contractor's mix design.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 415-3.02.

The uncompacted void content shall meet the minimum requirements specified in Subsection 415-3.02. 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 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).



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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.

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 between -2.0 and -12.0 percent, pay factors will be determined in accordance with Table 415-4. These pay factors will be utilized in the pay adjustment as outlined in Subsection 415-9.

### **415-7.04      Gradation, Asphalt-Rubber Content, and Effective Voids:**

A lot shall be considered to be one shift's production; however, production consisting of less than one shift, such as at the beginning or at the completion of production will also be considered to be a 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 shall be taken in accordance with the requirements of Section 2, paragraphs (d) through (f), or Section 3 of Arizona Test Method 104. 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 asphalt-rubber content, gradation, Marshall density, and maximum theoretical density. Asphalt-rubber content and gradation shall be tested in accordance with Arizona Test Method 427 using an ignition furnace, except the sample size specified in Section 3(c) of Arizona Test Method 427 shall be a minimum of 3000 grams. A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs. Marshall density and maximum theoretical density shall be tested in accordance with the requirements of Arizona Test Methods 410 and 417 respectively. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424.

For plants providing asphaltic concrete exclusively for this project, the difference between the asphalt-rubber content as measured by ignition furnace testing and the actual asphalt-rubber content shall be determined for the first five lots of asphaltic concrete produced for each mix design. 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 there is a difference of greater than 0.1 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. 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.

In the event the contractor elects to question the test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for referee testing of that lot. The referee testing shall be performed in an independent approved laboratory designated by the Engineer. 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 tests results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for Marshall density and maximum theoretical density in accordance with the requirements of Arizona Test Methods 410 and 417 respectively except, when testing for Marshall density, the specimens shall not be extruded from the molds until the day after they are compacted. Effective voids will be

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determined in accordance with the requirements of Arizona Test Method 424. The samples shall also be tested in accordance with Arizona Test Method 427 for asphalt-rubber content by ignition furnace and gradation of the mineral aggregate, except the sample size specified in Section 3(c) of Arizona Test Method 427 shall be a minimum of 3000 grams. New PT's will be determined for all characteristics, with the exception of asphalt-rubber content if a correction to the ignition furnace test value was made as specified above. 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 results of these determinations will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the total pay factor of the lot does not improve or is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

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	LL	UL
Gradation (sieve size):		
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: 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 of each measured characteristic in accordance with Subsection 415-9(I), and utilizing Table 415-4 the Engineer will determine pay factors for each measured characteristic.

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 while the mixture is still hot.

A lot for compaction purposes shall be identical to the lot described in Subsection 415-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 415-9 (D). 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. 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 one-half foot in the transverse direction and to the nearest one foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after the lot placement. The cores shall be delivered to the Engineer immediately upon being taken. The cores will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

The target value for compaction shall be 7.0 percent in-place air voids. In-place air voids shall be determined using Arizona Test Method 424. The maximum theoretical density used in determination of air voids will be the average of the four maximum theoretical densities determined in Subsection 415-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 4.0 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 will determine the compaction pay factor.

In the event the contractor elects to question the core test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for referee testing of that lot. The cores previously saved will be tested in accordance with the requirements of Arizona Test Method 415 in an independent testing laboratory designated by the Engineer. 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, the test results by the Department, or the density target. Using the referee test results, the Engineer will determine a new PT for

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compaction. The result of this determination will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the compaction pay factor of the lot does not improve, is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

### **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.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) 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 ten-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.
- (2) 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 ten-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.
- (3) 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 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. 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. 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 415-6.

#### **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 total pay factor as hereinafter provided.

For the purpose of determining acceptability and appropriate total 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 Engineer may exclude asphaltic concrete from the spread lot quantity 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 quantity and/or the compaction lot quantity 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. If the quantity in a spread lot is found to vary by more than +5.0 percent, no payment will be made for the material which exceeds the +5.0 percent, including asphalt-rubber and mineral admixture. If the quantity is found to vary by more than -12.0 percent, the spread lot will be rejected.

#### **(B) Mixture Properties Lot Pay Factor:**

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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.
- (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.
- (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) shall apply.

### **(C) Compaction Lot Pay Factor:**

The compaction lot pay factor shall be the compaction pay factor determined as set forth in Subsection 415-7.05.

### **(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.
- (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, 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), 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 415-9(C), 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; and a minus \$5.00 per ton each for mixture properties lots and compaction lots. 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. Positive compaction lot pay factors become zero when the mixture properties lot is in reject and is allowed to remain 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).

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 a professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected 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.

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 factors, 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.



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- (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 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, 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.

### **(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.

### **(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**

<b>Material Spread</b>		<b>Mixture Properties and Compaction</b>			
<b>Negative Variance %</b>	<b>Pay Factor (Dollars per Ton)</b>	<b>PT</b>	<b>Pay Factors (Dollar per Ton)</b>		
			<b>Gradation and Asphalt-Rubber Content</b>	<b>Effective Voids</b>	<b>Compaction</b>
2.1- 3.0	- 0.10	100	0.00	+ 1.00	+ 1.00
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	- 1.30
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)		

## **SECTION 416 ASPHALTIC CONCRETE - END PRODUCT:**

### **416-1 Description:**

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and an 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 these specifications.

It is the intent of this specification that the contractor acquire and make all arrangements for a source or sources of material; that it furnish Certificates of Compliance as hereinafter specified; that it furnish a mix design which will meet the design criteria specified hereinafter; and that it provide all the equipment, materials, and labor necessary to furnish and place the asphaltic concrete in accordance with the requirements specified herein.

### **416-2 Asphaltic Concrete Mix Design Criteria:**

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	
		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	815	
2. Effective Voids: %, Range		Note (1)	Note (1)	Note (1)	815	
3. Absorbed Asphalt: %, Range		0 - 1.0	0 - 1.0	0 - 1.0	815	
4. Index of Retained Strength: %, Minimum, Note (2)		60	60	60	802	
5. Wet Strength: psi, Minimum		150	150	150	802	
6. Stability: pounds, Minimum		2,000	2,000	3,000	815	
7. Flow: 0.01-inch, Range		8 - 16	8 - 16	8 - 16	815	
8. Mix Design Grading Limits					201	
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 in.					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
(1) As specified in the Special Provisions						
(2) For interstate roadways, if the average elevation of the project is above 3500 feet, the index of retained strength shall be a minimum of 70 percent.						

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 specified in the Special Provisions.

**416-3                    Materials:**

**416-3.01                Mineral Aggregate:**

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001-4.01 (B) shall not apply.

Coarse 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 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 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 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 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 aggregate up to a maximum of 15 percent of the total aggregate, provided that the composite of uncrushed fine aggregate and crushed fine aggregate meets the requirement for uncompacted void content. The uncrushed fine 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.

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.

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<b>Mineral Aggregate Characteristics</b>	<b>Test Method</b>	<b>Requirement</b>
Combined Bulk Oven Dry Specific Gravity	Arizona Test Methods 251	2.350 - 2.850
Combined Water Absorption	Arizona Test Methods 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
Abrasion	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 70% (1)(at least one fractured face, determined on plus No. 4 material)
Uncompacted Void Content (Special Mix Only)	Arizona Test Method 247	Minimum 45.0%
Carbonates (Only if the asphaltic concrete is the designed final pavement surface normally used by traffic; detours and temporary paving are excluded.)	Arizona Test Method 238	Maximum 20%
(1) 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.		

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. Abrasion shall be performed separately on materials 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, according to the contractor's mix design proposal, for combined bulk specific gravity and/or combined water absorption up to a maximum of 3.0 percent but meets other specified requirements will be further considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement 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.

#### **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.

<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

#### **416-3.03 Bituminous Material:**

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. 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  $0.17 \pm 0.02$  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  $0.28 \pm 0.03$  Pascal-seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. 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 °F or a maximum laboratory compaction temperature exceeding 300 °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

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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 416-6 and 416-7.

### **416-4 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 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 under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. 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 the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009.

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 asphalt cement and mineral admixture type and source of supply, 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 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. Any previously used mix design that is older than one year, but less than two years, shall not be allowed for use unless the contractor provides verification testing results. Such testing shall be a one-point verification at the design asphalt content utilizing the proposed mineral aggregate, asphalt cement, and mineral admixture. Once approved for use on a project, a mix design may be used for the duration of the project.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) 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.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture.
- (6) 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.
- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

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 mineral aggregate, mineral admixture, and asphalt cement 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. 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.



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The sand equivalent, fractured coarse aggregate particles, and (for Special Mix) uncompacted void content shall meet the requirements specified in Subsection 416-3.01. 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 of material, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

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. The 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	±2% from mix design target value
No. 8	±2% from mix design target value
No. 40	±1% from mix design target value
No. 200	None
Asphalt Cement 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.

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.

416-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in Subsection 106.04(C). 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.
- (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 Asphaltic Concrete			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176	Crusher Belt or Stockpile	1 per 2000 Tons of total aggregate (1)
Fractured Coarse Aggregate Particles	ARIZ 212		
Uncompacted Void Content (2)	ARIZ 247		
Asphaltic Concrete End-Product			
Gradation	ARIZ 201 or 427	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1000 Tons
Asphalt Content	ARIZ 421, 427, or other approved methods	Roadway or Plant	1 per 1000 Tons
Voids	ARIZ 415, 417, 424	Roadway or Plant	1 per 1000 Tons each day. Maximum of 4 per day.
Compaction	ARIZ 412	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.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 °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.

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 the work to cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

Longitudinal joints of each course shall be staggered a minimum of one 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 one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes.

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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.

A light coat of bituminous material shall be applied as directed 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 Arizona Test Method 406.

### **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:

Sand Equivalent

Fractured Coarse Aggregate Particles  
 Uncompacted void Content (for Special Mix)  
 Material Spread  
 Gradation  
 Asphalt Cement Content  
 Effective Voids  
 Stability  
 Compaction  
 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 mineral aggregate 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. 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 416-3.01 and the running average of three sand equivalent tests is at least 90 percent and no single test is less than 80 percent of the sand equivalent result contained in the contractor's mix design.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 416-3.01.

For Special Mix, the compacted void content shall meet the minimum requirements specified in Subsection 416-3.01. 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 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).

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

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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.

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 between -2.0 and -12.0 percent, pay factors will be determined in accordance with Table 416-1. These pay factors will be utilized in the pay adjustment as outlined in Subsection 416-9.

### **416-7.04            Gradation, Asphalt Cement Content, Effective Voids and Stability:**

A lot shall be considered to be one shift's production; however, production consisting of less than one shift, such as at the beginning or at the completion of production will also be considered to be a lot. If changes are made in the mix design, 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 shall be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 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 asphalt cement content, gradation, Marshall density and stability, and maximum theoretical density. Asphalt cement content and gradation shall be tested in accordance with Arizona Test Method 427 using an ignition furnace. A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs. Marshall density and stability, and maximum theoretical density shall be tested in accordance with the requirements of Arizona Test Methods 410 and 417 respectively. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424.

For plants providing asphaltic concrete exclusively for this project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined for the first five lots of asphaltic concrete produced for each mix design. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The

determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, 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 there is a difference of greater than 0.1 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, the contractor may request that a correction to the asphalt cement 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 cement content, was made to the asphalt cement content by ignition furnace testing, referee testing shall not apply to the determination of asphalt cement 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. 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 cement 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.

In the event the contractor elects to question the test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for referee testing of that lot. The referee testing shall be performed in an independent approved laboratory designated by the Engineer. 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 tests results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for Marshall density and stability, and maximum theoretical density in accordance with the requirements of Arizona Test Methods 410 and 417 respectively. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424. The samples shall also be tested in accordance with Arizona Test Method 427 for asphalt cement content by ignition furnace and gradation of the mineral aggregate. New PT's will be determined for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace value was made as specified above. 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.



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The results of these determinations will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the total pay factor of the lot does not improve or is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

A mixture-properties lot placed with an average stability below 2,500 pounds for base mixes, or 1,750 pounds for 1/2 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). 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	UL
Gradation (Sieve size):		
3/8 inch (Note 2)	TV - 6.0	TV + 6.0
No. 8	TV - 6.0	TV + 6.0
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 + 1.5
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).		
2) In the case of the 3/8 inch sieve requirement, for the base mix only, the lower limit shall be the target value minus 8.0, and the upper limit shall be the target value plus 8.0.		

The Engineer will determine the PT of each measured characteristic in accordance with Subsection 416-9(l), and utilizing Table 416-1, will determine pay factors for each measured characteristic.

- 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.

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250 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.

## **(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 eight 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 five 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
* 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 one 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 contractors 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 lot for compaction purposes shall be identical to the lot described in Subsection 416-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(D). 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 ten random locations within the lot, and the contractor shall take two cores at each location. 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 one-half foot in the transverse direction and to the nearest one foot in the longitudinal direction of the pavement course; however,

the outside one foot of the unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. Areas excluded from testing will be compacted in accordance with Subsection 416-705(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after the lot placement. The cores shall be delivered to the Engineer immediately upon being taken. The cores will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing 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 lift.

The target value for compaction shall be 7.0 percent in-place air voids. In-place air voids shall be determined using Arizona Test Method 424. The maximum theoretical density used in determination of air voids will be the average of the four maximum theoretical densities determined in Subsection 416-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 4.0 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 416-9(I), and utilizing Table 416-1 will determine the compaction pay factor.

In the event the contractor elects to question the core test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for the lot has been made, the contractor may make a written request for referee testing of that lot. The cores previously saved will be tested in accordance with the requirements of Arizona Test Method 415 in an independent testing laboratory designated by the Engineer. 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, the test results by the Department, or the density target. Using the referee test results, the Engineer will determine a new PT for compaction. The result of this determination will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the compaction pay factor of the lot does not improve, is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

#### **416-7.06      Smoothness and Surface Tolerances:**

Asphaltic concrete shall be compacted as required, smooth and true to the required lines, grades, and dimensions.

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The Special Provisions may require the smoothness of the final pavement surface to be tested in accordance with Subsection 109.13.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) 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 ten-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.
- (2) 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 ten-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.
- (3) 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.

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsection 416-7.04 for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results unless a correction, based on the actual asphalt cement content, was made to the ignition furnace test value as allowed in Subsection 416-7.04. If a correction, based on the actual asphalt cement content, was made to the ignition furnace test value, the average asphalt cement content determined from the Department's acceptance testing will be used. At the discretion of the Engineer, asphalt cement may be measured by invoice quantities, adjusted as necessary for waste. In no case shall the measured amount of asphalt cement 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 416-6.

**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 total pay factor as hereinafter provided.

For the purpose of determining acceptability and appropriate total 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 Engineer may exclude asphaltic concrete from the spread lot quantity 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 quantity and/or the compaction lot quantity, 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. If the quantity in a spread lot is found to vary by more than + 5.0 percent, no payment will be made for the material which exceeds the + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent, 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.
- (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

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than 50, the lot is in reject and the provisions in Subsection 416-9(E) shall apply.

### **(C) Compaction Lot Pay Factor:**

The compaction lot pay factor shall be the compaction pay factor determined as set forth in Subsection 416-7.05(B).

### **(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.
- (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, 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), 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), 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), 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 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; and a minus \$5.00 per ton each for mixture properties lots and compaction lots. 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. Positive compaction lot pay factors become zero when the mixture properties lot is in reject and the material is allowed to remain 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).

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 a professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected 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.

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 factors, 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.
- (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 416-4, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall



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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:**

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

**(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.

**(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 416-1 with PT.

**TABLE 416-1  
PAY FACTORS**

Material Spread		Mixture Properties and Compaction			
Negative Variance %	Pay Factor (Dollars per Ton)	PT	Pay Factors (Dollars per Ton)		
			Gradation and Asphalt Content	Effective Voids	Compaction
2.1 - 3.0	- 0.10	100	0.00	+ 1.00	+ 1.00
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	- 1.30
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)		

## **SECTION 417 ASPHALTIC CONCRETE (END PRODUCT) SHRP VOLUMETRIC MIX:**

### **417-1 Description:**

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture, and an 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 these specifications.

It is the intent of this specification that the contractor acquire and make all arrangements for a source or sources of material; furnish Certificates of Compliance as hereinafter specified; furnish a mix design which will meet the design criteria specified hereinafter; and provide all the equipment, materials, and labor necessary to furnish and place the asphaltic concrete in accordance with the requirements specified herein.

The type of asphaltic concrete mix shall be specified in the Special Provisions.

### **417-2 Asphaltic Concrete Mix Design Criteria:**

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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 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	As specified in the Special Provisions	
Absorbed Asphalt: %, Range	0 - 1.0	
Index of Retained Strength: % (Arizona Test Method 802)	60 Minimum (See Note 7 below)	
Wet Strength: psi (Arizona Test Method 802)	150 Minimum	

**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.
- (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, and 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.
- (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) In preparation of test specimens for Arizona Test Method 802, mineral aggregate samples shall be weighed up by replacing the plus 3/4 inch material of the composite with material which passes the 3/4 inch sieve and is retained on the 1/2 inch sieve. Arizona Test Method 802 shall be modified to require that the average bulk density for the specimens be 92.0% to 94.0% of the maximum theoretical density at the design asphalt content.

**TABLE 417-1 (Continued)**  
**ASPHALTIC CONCRETE MIX DESIGN CRITERIA**

- (5) 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.
- (6) Oven aging period for mix design gyratory samples shall be 2 hours.
- (7) For interstate roadways, if the average elevation of the project is above 3500 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

**TABLE 417-2 (Continued)**  
**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

**TABLE 417-2 (Continued)**  
**MIX DESIGN GRADING LIMITS**

**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" mix and 20 percent for the 3/4" mix. Intermediate size mineral aggregate is defined as the percentage of mineral aggregate passing the 3/8" sieve and retained on the No. 8 sieve in the combined mineral aggregate, exclusive of mineral admixture.

**417-3 Materials:**

**417-3.01 Mineral Aggregate:**

The contractor shall provide a source in accordance with the requirements of Section 1001, except that sub-paragraph (3) under Subsection 1001- 4.01(B) shall not apply.

Coarse 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 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 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 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.

The contractor may blend uncrushed fine 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, provided that the composite of uncrushed fine aggregate and crushed fine aggregate meets the requirement for uncompacted void content. The uncrushed fine 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.

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:

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<b>Mineral Aggregate Characteristics</b>	<b>Test Method</b>	<b>Requirement</b>
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
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Fractured Coarse Aggregate Particles	Arizona Test Method 212	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	ASTM D 4791 (except test shall be performed on plus No. 4 material)	Maximum 10% (of the plus No. 4 material) 5:1
Uncompacted Void Content	Arizona Test Method 247	Minimum 45.0%
Carbonates (Only if the asphaltic concrete is the designed final pavement surface normally used by traffic; detours and temporary paving are excluded.)	Arizona Test Method 238	Maximum 20%

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. Abrasion shall be performed separately on materials 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, according to the contractor's mix design proposal, for combined bulk specific gravity and/or combined water absorption up to a maximum of 3.0 percent, but which meets other specified requirements, will be further considered for acceptance by the

Engineer if: (a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement 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.

#### **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:

<b>Material</b>	<b>Requirement</b>
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 of the Standard Specification shall be submitted to the Engineer.

#### **417-3.03 Bituminous Material:**

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. 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  $0.17 \pm 0.02$  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  $0.28 \pm 0.03$  Pascal-seconds, measured in accordance with AASHTO T 316. The testing required in AASHTO T 316 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding



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325 °F or a maximum laboratory compaction temperature exceeding 300 °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 417-6 and 417-7.

### **417-4 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 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 under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. 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 the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21<sup>st</sup> Avenue, Phoenix, Arizona 85009-3740.

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 asphalt cement and mineral admixture type and source of supply, 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 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. Any

previously used mix design that is older than one year, but less than two years, shall not be allowed for use unless the contractor provides verification testing results. Such testing shall be a one-point verification at the design asphalt content utilizing the proposed mineral aggregate, asphalt cement, and mineral admixture. Once approved for use on a project, a mix design may be used for the duration of the project.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) 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.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) 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.
- (6) 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.
- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges, as well as the actual laboratory mixing and compaction temperatures used.

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.

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A copy of the mix design and representative samples of the mineral aggregate, mineral admixture, and asphalt cement 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. 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 417-3.01. 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 of material, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

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. The 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 No. 8 No. 40 No. 200	$\pm 2\%$ from the mix design target value $\pm 2\%$ from the mix design target value $\pm 1\%$ from the mix design target value None
Asphalt Cement Content	$\pm 0.2\%$ 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.

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.

#### **417-5 Contractor Quality Control:**

The contractor shall perform the quality control measures described in Subsection 106.04(C). 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.
- (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 Asphaltic Concrete			
Gradation	ARIZ 201	Crusher Belt or Stockpile	1 per stockpile per day
Sand Equivalent	AASHTO T 176	Crusher Belt or Stockpile	1 per 2000 Tons of total aggregate (1)
Fractured Coarse Aggregate Particles	ARIZ 212		
Uncompacted Void Content	ARIZ 247		
Asphaltic Concrete End-Product			
Gradation	ARIZ 201 or 427	Cold Feed, Hot Bins, Roadway, or Plant	1 per 1000 Tons
Asphalt Content	ARIZ 421, 427, or other approved methods	Roadway or Plant	1 per 1000 Tons
Voids	ARIZ 415, 417, 424	Roadway or Plant	1 per 1000 Tons each day. Maximum of 4 per day.
Compaction	ARIZ 412	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.			

#### **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.

The temperature of asphaltic concrete or mineral aggregate upon discharge from the drier shall not exceed 325 °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.

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 the work to cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be treated when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on ten foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one 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.

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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.

A light coat of bituminous material shall be applied as directed 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 Arizona Test Method 406.

### **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:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted Void Content

Material Spread  
 Gradation  
 Asphalt Cement Content  
 Effective Voids  
 Compaction  
 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 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 417-3.01 and the running average of three sand equivalent tests is at least 90 percent and no single test is less than 80 percent of the sand equivalent result contained in the contractor's mix design.

The fractured coarse aggregate particles shall meet the minimum requirements specified in Subsection 417-3.01.

The uncompacted void content shall meet the minimum requirements specified in Subsection 417-3.01. 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 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 416-9(D).

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.



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The Engineer will calculate the quantity required in each spread lot using the mix design bulk density.

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 between - 2.0 and - 12.0 percent, pay factors will be determined in accordance with Table 417-3. These pay factors will be utilized in the pay adjustment as outlined in Subsection 417-9.

### **417-7.04            Gradation, Asphalt Cement Content, and Effective Voids:**

A lot shall be considered to be one shift's production; however, production consisting of less than one shift, such as at the beginning or at the completion of production, will also be considered to be a lot. If changes are made in the mix design, 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 shall be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 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 asphalt cement content, gradation, gyratory density, and maximum theoretical density. Asphalt cement content and gradation shall be tested in accordance with Arizona Test Method 427 using an ignition furnace. A new calibration of the ignition furnace shall be performed for each mix design, and at any other time the Engineer directs. Gyratory density and maximum theoretical density shall be tested in accordance with the requirements of AASHTO T 312 and Arizona Test Method 417 respectively. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424.

For plants providing asphaltic concrete exclusively for this project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined for the first five lots of asphaltic concrete produced for each mix design. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, 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 there is a difference of greater than 0.1 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, the contractor may request that a correction to the asphalt cement 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 cement content, was made to the asphalt cement content by ignition furnace testing, referee testing shall not apply to the determination of asphalt cement 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. 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 cement 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.

In the event the contractor elects to question the test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for referee testing of that lot. The referee testing shall be performed in an independent approved laboratory designated by the Engineer. 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 tests results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for gyratory density and maximum theoretical density in accordance with the requirements of AASHTO T 312 and Arizona Test Method 417 respectively. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424. The samples shall also be tested in accordance with Arizona Test Method 427 for asphalt cement content by ignition furnace and gradation of the mineral aggregate. New PT's will be determined for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace value was made as specified above. 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 results of these determinations will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the total pay factor of the lot does not improve or is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

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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:

<b>Coarse Band 3/4" and 1/2" Mixes</b>		
Measured Characteristics	LL	UL
Gradation		
3/8" sieve	TV - 8.0	TV + 8.0
No. 8 sieve	TV - 5.0	TV + 5.0
No. 40 sieve	TV - 5.0	TV + 5.0
No. 200 sieve	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5

<b>Fine Band 3/4" and 1/2" Mixes</b>		
Measured Characteristics	LL	UL
Gradation		
3/8" sieve	TV - 6.0	TV + 6.0
No. 8 sieve	TV - 6.0	TV + 6.0
No. 40 sieve	TV - 5.0	TV + 5.0
No. 200 sieve	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5

Note: 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 Value (TV).

The Engineer will determine the PT of each measured characteristic in accordance with Subsection 417-9(l) and, utilizing Table 417-3, will determine pay factors for each measured characteristic.

### **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.

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250 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.

### **(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 eight 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:

<b>Rolling Sequence</b>	<b>Type of Compactor</b>		<b>No. of Coverages</b>	
	<b>Option No. 1</b>	<b>Option No. 2</b>	<b>Option No. 1</b>	<b>Option No. 2</b>
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2 - 4*
Finish	Static Steel	Static Steel	1 - 3	1 - 3
* Based on the roller pattern which exhibits the best performance.				

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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 one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 °F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 °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 contractors 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 lot for compaction purposes shall be identical to the lot described in Subsection 417-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 417-9 (D). 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 ten random locations within the lot and the contractor shall take two cores at each location. 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 one-half foot in the transverse direction and to the nearest foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. Areas excluded from testing will be compacted in accordance with Subsection 417-7.05 (A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after the lot placement. The cores shall be delivered to the Engineer immediately upon being taken. The cores will be tested for acceptance by the Engineer in accordance with the requirements of

Arizona Test Method 415. Acceptance testing 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 7.0 percent in-place air voids. In-place air voids shall be determined using Arizona Test Method 424. The maximum theoretical density used in determination of air voids will be the average of the four maximum theoretical densities determined in Subsection 417-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 4.0 percent in-place air voids. The Engineer will determine the PT for compaction in accordance with Subsection 417-9(l) and, utilizing Table 417-3, will determine the compaction pay factor.

In the event the contractor elects to question the core test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for referee testing of that lot. The cores previously saved will be tested in accordance with the requirements of Arizona Test Method 415 in an independent testing laboratory designated by the Engineer. 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, the test results by the Department, or the density target. Using the referee test results, the Engineer will determine a new PT for compaction. The result of this determination will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the compaction pay factor of the lot does not improve, is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

#### **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.

Regardless of whether testing in accordance with Subsection 109.13 is specified or not, the following requirements shall be met:

- (1) 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 ten-foot straightedge when it is placed in the longitudinal direction

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(including across transverse joints), and when it is placed in the transverse direction across longitudinal joints.

- (2) 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 ten-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.
- (3) 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.

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsection 417-7.04 for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results, unless a correction, based on the actual asphalt cement content, was made to the ignition furnace test value as allowed in Subsection 417-7.04. If a correction, based on the actual asphalt cement content, was made to the ignition furnace test value, the average asphalt cement content determined from the Department's acceptance testing will be used. At the discretion of the Engineer, asphalt cement may be measured by invoice quantities, adjusted as necessary for waste. In no case shall the measured amount of asphalt cement 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 417-6.

### **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 total pay factor as hereinafter provided.

For the purpose of determining acceptability and appropriate total 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 Engineer may exclude asphaltic concrete from the spread lot quantity 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 quantity and/or the compaction lot quantity 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. If the quantity in a spread lot is found to vary by more than + 5.0 percent, no payment will be made for the material which exceeds the + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent, 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.
- (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 417-9(E) shall apply.

**(C) Compaction Lot Pay Factor:**

The compaction lot pay factor shall be the compaction pay factor determined as set forth in Subsection 417-7.05 (B).

**(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:**



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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.
- (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, 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), 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), 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), 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 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; and a minus \$5.00 per ton each for mixture properties lots and compaction lots. 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. Positive compaction lot pay factors become zero when the mixture properties lot is in reject and the material is allowed to remain 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).

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 a professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected 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.

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 factors, 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.
- (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 417-4, 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:**

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Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

### (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.

### (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 417-3 with PT.

<b>TABLE 417-3 PAY FACTORS</b>						
<b>Material Spread</b>			<b>Mixture Properties and Compaction</b>			
<b>Negative Variance%</b>	<b>Pay Factor (Dollars per Ton)</b>		<b>PT</b>	<b>Pay Factors (Dollars per Ton)</b>		
				<b>Gradation and Asphalt Content</b>	<b>Effective Voids</b>	<b>Compaction</b>
2.1 - 3.0	- 0.10		100	0.00	+ 1.00	+ 1.00
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	- 1.30
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)		

**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 these 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 these specifications.

When trenching to depths in excess of five 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.

**501-2.02 Nonreinforced, Cast-In-Place:**

Concrete for constructing the cast-in-place concrete pipe shall conform to the requirements of Section 1006 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 one inch and for pipes larger than 48 inches in diameter shall be 1-1/2 inches.

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### **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 one 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 two feet for pipe under four feet in diameter, or a minimum of the outside diameter of the pipe plus three feet for pipe of four or more feet in diameter. The overexcavated area shall be backfilled with structure backfill material as designated in Subsection 203-5.03(B)(1) and compacted in layers not exceeding six 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) and compacted in six-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.

#### **501-3.02 Bedding:**

##### **(A) Bedding Material:**

##### **(1) General:**

Bedding material for all pipe shall conform to the following aggregate gradation:

<b>Sieve Size</b>	<b>Percent Passing</b>
1-1/2 inch	100
1 inch	90 - 100
No. 8	35 - 80
No. 200	0 - 8.0

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 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 Arizona Test Method 236.

### **(2) Standard Aggregate Bedding Material:**

Standard aggregate bedding material shall conform to the requirements specified in Subsection 501-3.02(A)(1) and may be compacted, jetted, or placed as an aggregate slurry as herein specified.

The maximum water content in an aggregate slurry mixture 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). 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). 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 eight 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

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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 six inches below the pipe to the springline.

For pipes placed in trench condition, a six-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:

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.

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 either in uniform horizontal layers not exceeding eight inches in depth before compaction or in uniform horizontal layers not exceeding four feet in depth when placed as a slurry. Bedding material may also be placed in uniform horizontal layers not exceeding four feet in depth when compaction is done by jetting.

### **(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 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 one foot above the top of the pipe.

Ponding will not be permitted in any case.

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 three feet.

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) and is placed as outlined in Subsection 501-3.02(B). The Engineer may require the use of vibrators with cement-treated slurry bedding if the fluidity of the



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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.

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 five 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 five 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.

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 or three by one inches shall be at least 10-1/2 inches wide. Bands for pipes 36 to 72 inches in diameter, inclusive, with corrugations five by one inches shall be at least 12 inches wide. Bands

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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 D 1056, 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.

Damaged galvanized coating shall be cleaned with a wire brush and the damaged area painted with at least one full coat of zinc paint, as specified in Subsection 1002-2.02. 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.

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 or 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 913-2.04. 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.

**(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, flexible watertight gasketed joints shall be installed on the pipe in accordance with the requirements of AASHTO M 198, Paragraph 5.1.

**(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) 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 repaired in accordance with the requirements of Subsection 1010-2(A). Coupling bands shall be supplied in accordance with Subsection 1010-2.03(C).

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 C 361, 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) 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 1010-2.02(A), 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 C 361, 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) Corrugated High Density Polyethylene Plastic Pipe:**

Corrugated high density polyethylene 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 these specifications.

A six- by eighteen-inch strip of magnetic tape shall be placed in the trench at the crown of each length of installed pipe.

Special care shall be taken in the handling and installation of corrugated high density polyethylene plastic pipe and fittings to prevent damage and to assure that proper line and pipe grade are maintained throughout the backfilling operation.

When end sections for corrugated high density polyethylene plastic 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:**

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Pipe backfill material shall be selected from excavation or from a source selected by the contractor. It shall not contain frozen lumps, stones larger than three 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 Arizona Test Method 236.

Pipe backfill material 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

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), 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 eight 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) 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 eight 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 one foot above the top of the pipe.

Trench backfill shall be placed from one 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.

**(2) Standard Aggregate Slurry:**

Pipe backfill or trench backfill mixed as a standard aggregate slurry shall be placed in uniform horizontal layers not exceeding four feet in depth. The slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(D).

**(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 one 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:**



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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 one foot above the top of the pipe.

Ponding will not be allowed in any case.

If trench backfill or pipe backfill is 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 one foot above the top of pipe if it meets the material requirements of Subsection 501-3.02(A) and is placed and compacted as outlined in Subsection 501-3.04(B) and (C). No density tests will be required in the cement-treated slurry bedding material when it is utilized for pipe backfill to an elevation one 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 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.

### **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 report will be available at Contracts and Specifications Section, 1651 W. Jackson, Phoenix, Arizona 85007, phone (602) 712-7221. 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

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control the grade and alignment of the trench. Departure from and return to the established grade for the finished trench shall not exceed one inch per ten 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 two inches per ten linear feet, with a total departure not to exceed four 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). The backfill shall be compacted in accordance with the requirements of Subsection 501-3.04(C). 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 six 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 one 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. 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 one inch per ten 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 ten foot straight edge. Departures from and return to specified alignment for the pipe shall not exceed two inches per ten linear feet, with a total departure not to exceed four 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 one 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).

#### **(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:

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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 six 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(C). 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.

### **(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  $0.0005 \times \text{O.D.}$  and that can be penetrated by a standard machinist gauge leaf designated in AASHTO T 280.
- (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 two 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 three 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 ten 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.

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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.

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) will be paid for in accordance with the provisions of Subsection 104.02.

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.

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, 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 for the class and strength shown on the project plans.

Reinforcing steel shall conform to the requirements of Section 1003.

### **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 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. Placement of reinforcing steel and structural concrete shall conform to the requirements of Sections 605 and 601, 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



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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 two 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 Subsection 102-2.02, 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.

#### **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. Payment for reinforcing steel used in footings and headwalls will be made as provided in Subsection 605-5. Payment for structural excavation and structure backfill for footings will be made as provided in Subsection 203-5.05.

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### **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 for Class B concrete.

##### **503-2.02 Reinforcing Steel:**

Reinforcing steel bars or mesh shall conform to the requirements of Section 1003.

##### **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 C 144. Portland cement and water shall conform to the requirements of Section 1006. Hydrated lime shall conform to the requirements of ASTM C 207, 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.

#### **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.

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 PRIDE 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 and reinforced where called for on the plans in accordance with the requirements of Section 605 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.

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

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for the new material. Frames and grates shall then be reinstalled according to the requirements of Subsection 503-3.01.

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. 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.

### **503-3.03            Frame and Grate:**

The fabrication of frame and grate units shall conform to the requirements of Subsection 604-3.06.

When reconstruct catch basin is specified, in accordance with Subsection 503-3.02, 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.

## **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.

**504-2.02 Concrete Pipe:**

Concrete pipe materials shall conform to the requirements of Section 1010.

**504-2.03 Mortar:**

Mortar for pipe joints shall conform to the requirements of Subsection 503-2.03.

**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 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.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5.

**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:**

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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.

## 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 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.

#### 505-2.02 Reinforcing Steel:

Materials furnished for reinforcing steel shall conform to the requirements of Section 1003.

#### 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.

#### 505-2.05 Frames and Covers:

Frames and covers shall conform to the requirements of Subsection 1004-6 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.

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.

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



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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. 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; 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.

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.

**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 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

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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 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, Galvanizing.

Welding shall be in accordance with the requirements in Subsection 604-3.06, 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 Arizona Test Method 201.

<b>Sieve Size</b>	<b>Percent Passing</b>
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 Arizona Test Method 212, 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.

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Resistance to abrasion for aggregate will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of 9 percent at 100 revolutions.

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.

### **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 six-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.

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### 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 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 °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 °C electric plastic conduit, EPC-40 or EPC-80, conforming to the requirements of NEMA Specification TC-2.
- (B) PVC plastic pipe, Schedule 40 or Schedule 80, conforming to the requirements of ASTM D 1785. The type, grade, and design stress designation of the pipe shall be either 1120, 1220, 2120, 2116, 2112, or 2110 as specified in ASTM D 1785.

Pipe shall be straight-end or bell-end. Bell and sockets shall conform to the requirements of ASTM D 2672 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  $22 \pm$  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 °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 D 2467 for Schedule 80 pipe and ASTM D 2466 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 Arizona Test Method 201:

<b>Sieve Size</b>	<b>Percent Passing</b>
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:

<b>Tests</b>	<b>Test Method</b>	<b>Requirement</b>
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Min. 90%
Abrasion	AASHTO T 96	500 Rev., Max. 45%
Sand Equivalent	AASHTO T 176	Min. 55



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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, 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.

**(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 Arizona Test Method 201:

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	Arizona Test Method 212	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, 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.

**(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 one-to-two (1:2), unless otherwise specified.

All materials used in the mortar shall conform to the requirements listed in Subsection 1006-2.

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

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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) 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 two 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 forty degrees F and in layers not to exceed eight 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 six 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 six 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

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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 one-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.

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### **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 these specifications. When the structures or parts of structures are precast, the work shall also include transporting and erecting the units.

Concrete structures such as 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 structures. Minor 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 requirements which may be found in the Special Provisions.

#### **601-2 Materials:**

##### **601-2.01 General:**

Portland cement concrete shall conform to the requirements of Section 1006 for Class S or Class B concrete as shown on the project plans.

Where a 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.

Liquid membrane-forming compound shall conform to the requirements of Subsection 1006-2.05.

Materials furnished for expansion joint filler and joint seal shall conform to the requirements of Section 1011.

Materials furnished for water stops shall conform to the requirements of Section 1011.

Preformed bearing pads and elastomeric bearing pads shall conform to the requirements of Section 1013.

Reinforcing steel shall conform to the requirements of Section 1003.

#### **601-3 Construction Requirements:**

##### **601-3.01 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. No concrete shall be placed under water or against water-bearing strata, except where a tremie concrete procedure is allowed by the Engineer.

**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.

Forms shall be any system of structural elements which provides horizontal support or restraint to the lateral pressure of concrete.

Falsework shall be any system of structural elements that provides temporary 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.

The design load for falsework shall consist of the sum of dead and live vertical loads, and an assumed horizontal load. The minimum total design load for any falsework shall be not less than 100 pounds per square foot for the combined live and dead load regardless of 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 two percent of the total dead load. The falsework shall be designed so that it will have sufficient rigidity to resist the assumed horizontal load without considering the weight of the concrete.



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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 Standard Specifications for Highway Bridges. The maximum allowable stresses provided for in the National Design Specification for wood construction (NDS) 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 will be 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 and 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.

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 will equal 100 percent capacity of the smaller member connected.

The falsework shall be located so that falsework footings or piles are at least three inches clear of railing posts and barriers and all other falsework members are at least one 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 one inch thick (nominal). Bracing on such bents shall be adequate so that the bent will resist 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.

The drawings shall be complete and fully detailed working drawings showing 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 as convenient 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 any embankments used, 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 embankment be compacted to less than 90 percent compaction, and the top three feet shall be compacted to a minimum of

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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 embankment shall be topped with a lean concrete waste slab screeded to the required grades.

Falsework design will require written approval by the Engineer prior to commencing work and shall be in accordance with the requirements of Subsection 105.03.

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.

Modification 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 to support deck forming. 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. 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 will have to be made in the roadway profile or in the girder bearing seat elevations. Encroachment into the deck slab of up to 1/2 inch will be allowed for random occurrences.

### **(B) Falsework Construction:**

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 will support the loads imposed on the falsework.

Falsework shall be founded on a solid footing safe against undermining and capable of supporting the loads imposed.

No concrete shall be placed in any forms supported by falsework until the contractor's professional engineer has inspected the completed falsework and has issued a properly signed and sealed certificate that the falsework has been constructed according to the approved falsework drawings.

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 insure 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 being placed.

If any weakness develops 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.

**(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.

The forms shall be mortar tight and shall be designed, constructed, braced and maintained so that the finished concrete will be true to line and elevation and will conform to the required dimensions and contours. They 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 meshes may be used to form construction joints providing:

- (a) Three-inch edge cover is maintained, and
- (b) Use in bridge decks is prohibited.

Forms reused shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity, watertightness 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

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caulked in an acceptable manner. 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.

All forms shall be treated with an approved form release agent before concrete is placed. Any material which will 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, watertightness and smoothness of the surface. All lumber for forms above stream bed 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 which will be exposed 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 will 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 ones near the top. Panel end joints shall be staggered not less than three 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:

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.

Care shall be exercised to keep the forms free of dust, grease or other foreign matter which will tend to discolor the concrete.

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 with Subsection 601-4.02(B).

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), 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 two 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:**

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

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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:

- (1) 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
- (2) 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. 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). 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 five 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 will remain 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.

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 six inches.

### **601-3.03        Placing Concrete:**

#### **(A)        General Requirements:**

No concrete shall be placed in any structure 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 by the contractor and all work required for the proposed pour has been completed.

Reinforcing steel shall be placed in accordance with the requirements of Section 605 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 will not cause harmful segregation and will result in a dense homogeneous concrete free of honeycomb or voids.

Concrete shall be placed in horizontal layers not over 24 inches in depth unless otherwise approved by the Engineer.



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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 eight 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), Fixed Form-Manual Methods.

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 will 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 will indicate 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 members.

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.

### **(B) Bridge Deck:**

The placing of concrete will not be 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 will be no void 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 will permit 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 a drawing 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 will be 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 will cease.

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 three inches and have a minimum length of 12 feet. The float shall be constructed so that the surface will be maintained true at all times.

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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  $\pm 1/4$  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 will be 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 six 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 insure 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:**

Where the roadway portion of a bridge deck widening 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).

Where the roadway portion of a bridge deck widening 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).

**(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:**

Except as otherwise specified herein, construction joints shall be constructed at the locations specified on the project plans.

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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.

Steel shapes and plates shall conform to the requirements of ASTM A 36 or A 588.

#### **(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 shall be submitted.

**(b) Shop Drawings:**

Prior to fabrication, the contractor shall submit eight sets of shop drawings to the Engineer for approval in accordance with the requirements of Subsection 105.03. 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.

**(c) Elastomer Seals:**

Seals shall conform to the requirements hereinbefore specified.

**(d) Welding:**

All welding shall be in accordance with the requirements of Subsection 604-3.06.

**(e) Armor:**

All metal for cast-in-place seal assemblies shall be steel conforming to the requirements hereinbefore specified.

**(f) Galvanizing:**

All metal parts of strip seal assemblies shall be galvanized after fabrication in accordance with the requirements of ASTM A 123 and A 153, unless ASTM A 588 steel is used. Bolts shall be high strength, conforming to the requirements of ASTM A 325, with a protective coating of cadmium or zinc followed by a chromate and baked organic coating according to ASTM F 1135, Grade 3, 5, 6, 7 or 8 and Color Code A.

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Metal parts of compression seal assemblies do not require galvanizing, plating, or painting.

### **(g) 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 will not be 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.

### **(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 nonshrink 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 will 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 pleasing 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 pleasing 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 one 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.

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 members 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 a 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:**

When specified on the project plans, bridge decks that will be covered with a special riding surface, or waterproofing membrane, shall not be textured and shall be finished to a smooth floated surface free of mortar ridges, hollows, and any other projections prior to curing.

The finishing operation shall be completed before the water sheen disappears. Water shall not be applied to the deck surface at any time during floating or finishing except that a fog spray may be applied.



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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 finished surface of the concrete shall be tested with a 10 foot straightedge placed on the deck surface. The surface plane shall not vary by more than 1/8 inch, as measured from the bottom of the straightedge, on deck surfaces exposed directly to traffic. 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.

Areas showing deviations greater than those specified shall be corrected in a manner approved by the Engineer. All corrected areas shall be textured to match the finish of the surrounding deck surface.

Where the surface will be exposed directly to traffic, it shall be textured transversely, after final floating in the plastic concrete or after the completion of the curing period to produce a uniformly grooved surface. Widened bridge decks shall be finished to match the existing deck surface texture.

The apparatus producing the textured 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 timing of the texturing 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.

Bridge sidewalks shall be finished to a light broomed texture.

### **601-3.06           Curing Concrete:**

Curing cast-in-place concrete and curing precast concrete members shall be in accordance with the requirements of Subsection 1006-6.

### **601-3.07           Supporting, Handling, and Transporting Precast Concrete Items:**

After prestressing, precast members for major structures shall be handled or supported at or near the final bearing points for storage.

Precast items shall be supported during transporting in a manner that will allow reasonable 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 will be embedded in a subsequent concrete pour, will have a minimum concrete cover of two inches, and will not interfere with the placement of reinforcing steel or concrete.

#### **601-3.08 Backfilling:**

Structure backfill shall be placed in accordance with the requirements of Subsection 203-5.03(B).

#### **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 these 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 A 603 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, which ever 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.

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Tempered hardboard shall conform to Federal Specification LLL-B-810, Type II, smooth one side, plain. Hardboard shall be 1/8 inch minimum thickness, unless shown or specified otherwise.

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 C 203, and a compressive yield strength of between 16 and 40 pounds per square inch, at five 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.

#### **601-4 Tests on Finished Structures:**

##### **601-4.01 Surface Texture:**

The grooves for decks exposed directly to traffic shall be 1/16 to 1/8 inch in width and 3/32 to 6/32 inch in depth. The textured groove depth will be measured in accordance with the requirements of Arizona Test Method 310. The center spacing of the grooves shall be 1/2 to one inch.

##### **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 follows:

- (1) Variation from plumb in the lines and surfaces of columns, piers, abutment and girder walls:

In any 10-foot-or-less length:	3/8 inch
Maximum for the entire length:	1 inch

- (2) Variation in cross-sectional dimensions of columns, piers, girders, and in the thickness of slabs and walls:

+ 1/4 inch  
- 1/8 inch

- (3) Girders alignment (deviation from straight line parallel to center line of girder measured between diaphragms):

1/8 inch per every 10 feet in length

- (4) Variation in footing cross sectional dimensions in project plans:

+ 2 inches  
- 1/2 inch

- (5) Variation in footing thickness:

\*Greater than specified: No Limit

Less than specified: 5 percent of specified thickness  
up to a maximum of one inch

\*Does not apply to reinforcing steel placement.

- (6) Subgrade Tolerances:

Slab poured on subgrade excepting footing thickness:

+ 1/4 inch  
- 3/4 inch

- (7) Girder Bearing Seats:

Deviation from plane surface (flatness):

$\pm$  1/8 inch in ten feet.

Deviation from required elevation:

- 1/4 inch  
+ 1/8 inch

- (8) Cast-In-Place concrete box girder superstructures:

Deviation in overall depth:

+ 1/4 inch  
- 1/8 inch

Deviation in slab and wall thickness:

+ 1/4 inch  
- 1/8 inch

Deviation of post-tensioning ducts:

$\pm$  1/4 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 will 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 follows:

- (a) Length:  $\pm$  3/4 inch
- (b) Width (flanges and fillets): + 3/8 inch, - 1/4 inch
- (c) Depth (overall): + 1/2 inch, - 1/4 inch
- (d) Width (web): + 3/8 inch, - 1/4 inch
- (e) Depth (flanges and fillets):  $\pm$  1/4 inch
- (f) Bearing plates (ctr. to ctr.):  $\pm$  1/8 inch per 10, but not greater than  $\pm$  3/4 inch
- (g) Horizontal alignment (deviation from straight line parallel to center-line of member): 1/8 inch per every 10 feet in length
- (h) Stirrup bars (deviation from top of beam): + 1/4 inch  
- 3/4 inch
- (i) Tendon position:  $\pm$  1/4 inch c.g. of strand group and individual strands
- (j) Horizontal position of deflection points for deflected strands:  $\pm$  10 inches

- (k) Position of handling devices:  $\pm 6$  inches
- (l) Bearing plates (ctr. to end of beam):  $\pm 1/4$  inch
- (m) Side inserts (ctr. to ctr. and ctr. to end):  $\pm 1/2$  inch
- (n) Exposed beam ends (deviation from square or designated skew):
  - Horizontal:  $\pm 1/4$  inch
  - Vertical:  $\pm 1/8$  inch per foot of beam depth
- (o) Bearing area deviation from plane:  $\pm 1/8$  inch
- (p) Stirrup bars (longitudinal spacing):  $\pm 1$  inch
- (q) Position of post-tensioning duct:  $\pm 1/4$  inch
- (r) Position of weld plates:  $\pm 1$  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 follows:

- (a) Length:  $\pm 3/4$  inch
- (b) Width (over-all):  $\pm 1/4$  inch
- (c) Depth (over-all):  $\pm 1/4$  inch
- (d) Width (web):  $\pm 3/8$  inch
- (e) Depth (top slab):  $\pm 1/4$  inch
- (f) Depth (bottom slab):  $+ 1/4$  inch,  $- 1/8$  inch
- (g) Horizontal alignment (deviation from straight line parallel to center line of member):  $1/8$  inch per every 10 in length
- (h) Camber differential between adjacent units:
  - Not greater than  $3/4$  inch
- (i) Position of tendons:  $\pm 1/4$  inch c.g. of strand group
- (j) Longitudinal spacing of stirrup bars:  $\pm$  one inch

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- (k) Position of handling devices:  $\pm 6$  inches
- (l) Slab Void position:  $\pm 1/2$  inch from end of void to center tie hole + 1 inch adjacent to end block
- (m) Square ends (deviation from square):  $\pm 1/2$  inch
- (n) Skew ends (deviation from designated skew):  $\pm 1/2$  inch
- (o) Beam seat bearing area (variation from plane surface when tested with a straightedge through middle half of member):  
 $\pm 1/8$  inch
- (p) Dowel tubes (spacing between the centers of tubes and from the centers of tubes to the ends and sides of members):  
 $\pm 1/2$  inch
- (q) Tie rod tubes (spacing between the center of tubes and from the centers of tubes to the end of the member):  $\pm 1/2$  inch
- (r) Tie rod tubes (spacing from centers of tubes to the bottom of the beams):  $\pm 3/8$  inch
- (s) Total width of deck: Theoretical width  $\pm 1/2$  per joint
- (t) Position of side inserts:  $\pm 1/2$  inch
- (u) Position of weld plates:  $\pm 1$  inch

### **(4) Precast Minor Structures:**

The maximum allowable tolerances or deviations from the dimensions shown on the drawings shall be as follows:

- (a) Over-all dimensions of member:  $\pm 1/4$  inch per 10 feet; maximum of  $\pm 3/4$  inch
- (b) Cross-sectional dimensions:
  - Sections six inches or less:  $\pm 1/8$  inch
  - Sections 18 inches or less and over 6 inches:  $\pm 3/16$  inch
  - Sections 36 inches or less and over 18 inches:  $\pm 1/4$  inch
  - Sections over 36 inches:  $\pm 3/8$  inch
- (c) Deviations from straight line:

Not more than 1/4 inch per 10 feet

All exposed, sharp corners of the concrete shall be filleted 3/4 inch with a maximum allowable deviation of  $\pm 1/8$ .

#### **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.

#### **601-4.04            Opening to Traffic:**

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.

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.

#### **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 members 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 incidental to the sealing of the joint.

Measurement for vertical restrainers will be made for each restrainer acceptably installed in place for each bridge.



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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.

No measurement or direct payment will be made for grooving of the bridge deck, the cost being considered as included in contract items.

### **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 1006-7.06(B).

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, including the seal, anchorage system, galvanizing, equipment and labor.

The accepted quantities of Vertical Restrainers, as measured above, will be paid for in accordance with the provisions of Subsection 109.10, 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.

## **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 these 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 members 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.

Prestressing steel shall be high-tensile steel wire, high-tensile seven-wire strand or high-tensile alloy bars, as shown on the project plans.

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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:**

Cement grout for bonding post-tensioning tendons shall consist of not more than five gallons of water to one 94-pound bag of Portland cement and may contain chemical admixtures if approved by the Engineer. Chemical admixtures shall conform to the requirements of Subsection 1006-2.04, except no admixtures containing chlorides or nitrates shall be used.

Portland cement shall be Type II conforming to the requirements of Subsection 1006-2.01.

Water shall conform to the requirements of Subsection 1006-2.02.

### **602-2.04         Structural Steel:**

Material furnished for structural steel shall conform to the requirements of Section 1004.

### **602-2.05         Portland Cement Concrete:**

Portland cement concrete shall conform to the requirements of Section 1006 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 members shall be submitted in accordance with the requirements of Subsection 105.03.

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 calibration.

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 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.

**(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.

**(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

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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 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.

### **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 AASHTO Division II, 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 AASHTO Article 9.7.2 Division I - Design. 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 AASHTO Article 10.3.3 Division II - Construction. If special anchorage devices are used, the contractor is responsible for furnishing anchorage devices that satisfy the acceptance test requirements of Division I, Article 9.21.7.3 and of Division II, 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 Division II, 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 tested and approved by the California Department of Transportation (Caltrans) will be considered an acceptable alternate to the AASHTO testing criteria. A copy of the approval letter from the Caltrans "Division of New Technology and Research," 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, 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 its 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.

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The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute 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 will not be 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  $\pm 1/4$  inch of the dimensions shown on the approved shop drawings.

After installation in the forms, the ends of ducts shall at all times be covered 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 will 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 Standard Specifications for Highway Bridges. 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 six inches in diameter or a digital display indicator. The increments shown on the reading dial gauge shall not exceed two 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 one percent of the load, from one percent to one hundred 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



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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 five 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.

Detensioning shall be performed immediately following the curing period if the concrete has been heat-cured. The release of the strands shall be from one or both ends of the casting bed depending upon which method will produce the least movement of members in the casting bed and the least horizontal eccentricity of the initial prestressing force in the member.

All pretensioned members shall be tensioned either by single strand or multiple strand jacks.

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.

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.

Splicing of strands will be permitted but only one splice per strand will be allowed. Strands to be spliced shall have the same lay or direction of twist. Splicing will not be permitted within the member.

When ordered by the Engineer, prestressing strands in precast members, if tensioned individually, shall be checked by the contractor for loss of force not more than three hours prior to placing concrete for the members. 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 three percent shall be retensioned to the original jacking force.

When concrete has not been placed within seventy-two 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 calendar 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 will not be covered by concrete, the anchoring devices shall be recessed so that the ends of

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the prestressing steel and all parts of the anchoring devices will be at least two inches inside of the end surface of the members, 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 will produce 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 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 out the ducts shall be oil free.

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.

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 will prevail during and following the placement of grout, the contractor shall provide adequate means to protect the grout in the ducts from damage by freezing.

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 members shall comply with the requirements of Subsection 601-3.05. In addition, those exterior surfaces of exterior bridge members 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 trowel 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 will not be 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 are allowed to harden and other foreign materials to remain on the bars, then abrasive blast methods will be conducted for cleaning. The cleaning of exposed epoxy-coated reinforcing steel shall be limited to

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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).

The work described in this subsection shall be accomplished in the production yard of the precast manufacturer. When the fabrication of any precast bridge member has been successfully completed, as determined by inspection, the unit will then be approved for transportation.

### **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 the precast concrete item.

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.

Payments will be made on the basis of the following:

- (1) Installation of Ducts: 25 Percent of Contract Lump Sum
- (2) Installation of Tendons: 50 Percent of Contract Lump Sum
- (3) Completion of Tensioning: 15 Percent of Contract Lump Sum
- (4) 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.

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.

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Reinforcing steel shall be as shown on the project plans and shall conform to the provisions of Section 1003.

### **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.

Precast concrete piles shall be constructed in accordance with the details shown on the plans and in accordance with the requirements of Section 601. Prestressing shall be in accordance with the requirements of Section 602 using the pretensioning method.

Steel reinforcement shall conform to the requirements of Section 1003.

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 two inches or rounded to a two-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 D 25. 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.

#### **603-2.06          Certificates:**

Certificates of Analysis conforming to the requirements of Subsection 106.05 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 six 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



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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.

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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.

### **(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 six 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 two 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.

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

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less than five 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 three 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.

### **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 two feet below the ground surface or two 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.

### **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.

<b>TABLE 603-1</b>		
Type of Pile	Type of Hammer	Formula
Timber and Steel	Drop	$P = \frac{2 F H}{S + 1.0}$
Metal Shells for Cast-In-Place Concrete, Timber, and Steel	Single-Acting Power	$P = \frac{2 F H}{S + 0.1}$
	Double-Acting Power (Use either formula)	$P = \frac{2 H (F + A p)}{S + 0.1}$ $P = \frac{2 E}{S + 0.1}$
<p>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.</p>		

The formulas in Table 603-1 are applicable only when:

The hammer has a free fall, except for double-acting hammers.

The head of the pile is not broomed or crushed.

The penetration is reasonably uniform.

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.

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### **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.

#### **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.

#### **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, will be made for this 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 A 36, 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



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longitudinal Charpy V-notch impact value requirements specified herein. Sampling procedures shall conform to the provisions in ASTM A 673. The H (Heat) frequency of testing shall be used for structural steels conforming to ASTM A 36, A 572 and A 588. The P (Piece) frequency of testing shall be used for structural steel conforming to ASTM A 514. Charpy V-notch impact values shall be determined in accordance with ASTM E 23.

Charpy V-notch (CVN) impact values shall conform to the following minimum values:

<b>Material</b>	<b>Impact Value: (foot-pounds at Temp. °F)</b>
ASTM A 36	15 at 40 °F
ASTM A 572*	15 at 40 °F
ASTM A 588* 2 inches and under	15 at 40 °F
ASTM A 588* Over 2 to 4 inches	20 at 40 °F
ASTM A 514 2-1/2 inches and under	25 at 0 °F
ASTM A 514 Over 2-1/2 to 4 inches	35 at 0 °F
*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 A 502.

### **604-2.03 High-Strength Bolts, Nuts and Washers:**

High Strength Bolts shall conform to ASTM A 325 except as may be modified herein.

The maximum hardness for ASTM A 325 bolts shall be 34 R<sub>C</sub>.

Nuts and washers, appropriate to the type of high strength bolt to be used, shall conform to ASTM A 563 or A 194, for nuts, and F 436, 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 A 325, 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.
- (c) The measured torque to produce the Required Fastener Tension shall not exceed the value obtained by the following equation:

$$\text{Torque} = 0.25 \text{ PD}$$

Where:

$$\begin{aligned} \text{Torque} &= \text{Measured Torque, in foot-pounds} \\ P &= \text{Measured Bolt Tension, in pounds} \\ D &= \text{Diameter, in feet} \end{aligned}$$

**(2) Proof Load Tests:**

Proof load tests, performed by the manufacturer, are required for the bolts (ASTM A 325) and for the nuts (ASTM A 563 or A 194). 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 Test Method F 606 – WEDGE TEST METHOD as described in Section 3.5 of that standard. 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 E 18 within the specified maximum shown above for bolts. Nuts and washers will only be tested for Rockwell hardness, in accordance with ASTM E 18, to confirm compliance with ASTM A 563 or A 194 for nuts and F 436 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 incidental to the cost of related contract items.

Suitable nuts shall conform to the requirements of ASTM A 563 and suitable hardened washers shall conform to the requirements of ASTM F 436.

**604-2.04 Bolts and Nuts:**

Bolts and nuts shall conform to the requirements of ASTM A 307.

**604-2.05 Steel Forgings:**

Steel forgings shall conform to the requirements of Subsection 1004-5.

**604-2.06 Castings:**

Carbon steel castings, gray iron castings and malleable iron castings shall conform to the requirements of Subsection 1004-6.

**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.

**604-2.08 Welded Stud Shear Connectors:**

Shear connector studs shall conform to the requirements of ASTM A 108, 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.

**(B) Elastomeric Bearing Pads:**

Elastomeric bearing pads shall conform to the requirements of Section 1013.

**604-2.10 Certification of Structural Steel:**

Certificates of Analysis conforming to the requirements of Subsection 106.05 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 shall also include the results of the Charpy V-notch impact test values.

**604-3 Construction Requirements:****604-3.01 Shop and Working Drawings:**

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Prior to fabrication, the contractor shall prepare shop and working drawings in accordance with the requirements of Subsection 105.03.

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 Division II, Construction, Section 11, Steel Structures, of AASHTO Standard Specifications for Highway Bridges, except as specified herein.

The structural steel fabricating plant shall be certified under the AISC Quality Certification program as follows:

Category I:          Fabrication of simple or continuous rolled beam bridges.

Category III:        Fabrication of all bridge structures other than simple or continuous rolled beam bridges.

Fabrication of steel components shall not begin until arrangements have been made for shop inspection.

In planning 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:**

In order that shop inspection may be provided for structural steel fabrication, written notice shall be given to the Engineer at least three months prior to beginning work in the shop and the Engineer shall be verbally notified at least 24 hours prior to the need for inspection in the shop.

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.

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 A 123. 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 A 123. 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 A 123.

Steel fittings, hardware, etc., shall be galvanized, when specified, in accordance with the requirements of ASTM A 153. The weight of the coating shall be as specified in ASTM A 153.

**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.

**604-3.08 Erection:**

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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.

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.

Partial payment may be made in accordance with the provisions of Subsection 109.07.

**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.

**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



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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. Where reinforcement spacing is less than 12 inches in each direction alternate intersections may be tied. Tack welding of reinforcement will not be permitted unless approved in writing by the Engineer. If tack welding of reinforcement is approved the reinforcement shall be deformed and shall conform to the requirements of ASTM A 706.

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:

In slabs and beams, horizontal bars shall be within 1/4 inch, measured vertically, of the position indicated on the plans.

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.

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.

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

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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 two 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 two 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 five 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:**

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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 three 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.

<b>TABLE 605-1</b>		
<b>Deformed Bar Designation No.</b>	<b>Weight, pounds per linear foot</b>	<b>Nominal Diameter, inches</b>
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: 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:**

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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.

Sign structures shall be of the following types: bridge truss, cantilever truss, tubular overhead, tubular cantilever, bridge tapered tube single beam, cantilever tapered tube double arm, and sign attachment structure for existing bridge. The type of sign structure to be installed at each location will be shown on the project plans.

### **606-2                Materials:**

#### **606-2.01            General:**

Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted for all structural steel. Mill test reports for structural steel used as specified under Subsection 606-2.02 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 A 36.

Structural steel used for the fabrication of column 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.

#### **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 requirements of ASTM A 595, Grade A.

#### **606-2.04            Pipe Poles for Cantilever Truss:**

Poles shall be welded or seamless steel pipe conforming to the requirements of ASTM A 53, Type E or S, Grade B.

#### **606-2.05            Bolts, Nuts and Washers:**

High-strength steel bolts, nuts and washers shall conform to the requirements of ASTM A 325. All other bolts and nuts shall conform to the requirements of ASTM A 307, and shall be furnished with commercial quality washers.

Anchor bolts for the sign foundations shall conform to the requirements of ASTM A 36.

All bolts, nuts, and washers, except high-strength bolts and anchor bolts, shall be cadmium plated in accordance with the requirements of ASTM B 766 or zinc plated in accordance with the requirements of ASTM B 633.

**606-2.06 Concrete:**

Concrete for all sign structure foundations shall be Class S ( $f'_c = 3,000$  pounds per square inch) conforming to the requirements of Section 1006.

**606-2.07 Reinforcing Steel:**

Reinforcing steel bars shall conform to the requirements of ASTM A 615, Grade 40. Reinforcing steel wire shall conform to the requirements of ASTM A 82.

**606-2.08 Nonshrink Grout:**

Nonshrink grout shall conform to the requirements of the Corps of Engineers Specification for Nonshrink Grout CRD-C 621 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. 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 Division II, Construction, Section 11, Steel Structures, of the AASHTO Standard Specifications for Highway Bridges.

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.

**606-3.03 Welding:**

Welding of tubular structural steel shall conform to the requirements of Section 10 of AWS D1.1-80, Structural Welding Code, of the American



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Welding Society. The welding of all other structural steel shall conform to Subsection 604-3.06.

### **606-3.04 Galvanizing:**

All steel surfaces of sign structures shall be galvanized after fabrication. Galvanizing shall conform to the requirements of ASTM A 123 and A 153.

### **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 Subsection 609-1 through 609-3.

Concrete shall be placed, finished and cured in accordance with the requirements of Section 601.

### **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 foundations 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 these specifications.

Sign supports shall consist of breakaway, 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 shall be submitted for breakaway sign post shapes

Certificates of Compliance conforming to the requirements of Subsection 106.05 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 A 572, Grade 50 or ASTM A 588 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 A 325.

Posts and plates shall be galvanized after fabrication in accordance with the requirements of ASTM A 123. Bolts, nuts and washers shall be cadmium plated in accordance with the requirements of ASTM B 766, or zinc plated in accordance with the requirements of ASTM B 633.

**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

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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 A 653 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  $5/32 \pm 1/32$  inch.

External welded surfaces and scarfed areas shall be re-galvanized after fabrication.

Holes  $7/16 \pm 1/64$  inch in diameter shall be provided on one-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 PRIDE program.

Bolts shall conform to the requirements of SAE Specification J 429, Grade 5, or ASTM A 449, Type 1. Nuts shall conform to the requirements of ASTM A 563, Grade A. Washers shall conform to the requirements of ASTM F 844.

Bolts, nuts and washers shall be zinc coated in accordance with the requirements of ASTM B 633 or cadmium plated in accordance with the requirements of ASTM B 766.

### **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 A 1 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 five percent. The post shall be punched with continuous 3/8-inch diameter holes on one-inch centers. The first hole shall be one 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 six-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 eighteen holes in the base post, starting one inch from the top and continuing at one-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 three feet.

Posts shall be galvanized after fabrication in accordance with the requirements of ASTM A 123. Bolts, nuts, washers and spacers shall be cadmium plated in accordance with the requirements of ASTM B 766 or zinc plated in accordance with the requirements of ASTM B 633.

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 eight inches and to a depth sufficient to place Portland cement concrete two inches below the

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bottom of the base post and fill the hole to within one 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 and utility concrete to the requirements of Section 922. 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.

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 A 123.

Reinforcing steel bars for breakaway sign post foundations shall conform to the requirements of ASTM A 615, Grade 40. Reinforcing steel wire shall conform to the requirements of ASTM A 82.

### **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, 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 two 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, as the case may be. Excavation shall conform to the requirements of Subsection 203-5.03(A).

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.

#### **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.

#### **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.

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### 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:

- Extruded Aluminum Sign Panels With Demountable Characters
- Flat Sheet Aluminum Sign Panels With Direct-Applied or Silk-Screened Characters
- Warning, Marker, and Regulatory Sign Panels
- Route Shields for Installation on Sign Panels
- EXIT ONLY for Installation on Sign Panels

#### 608-2 Materials:

##### 608-2.01 General:

Certificates of Compliance, conforming to the requirements of Subsection 106.05, 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.

##### 608-2.02 Extruded Aluminum Sign Panels With Demountable Characters:

Panels shall be fabricated from 12-inch wide aluminum extrusions formed from Aluminum Alloy 6063-T6 conforming to the requirements of ASTM B 221 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.

The letters, numerals, symbols, borders and other features of the sign message shall conform to the requirements of Subsection 608-2.14, Demountable Characters.

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 eight-foot length, with proportionally greater tolerances permitted on lengths greater than eight 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 B 221. 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	Blank	
608-2.04	Blank	
608-2.05	Blank	
608-2.06	Blank	
608-2.07	Flat Sheet Aluminum Sign Panels With Direct-Applied or Silk-Screened Characters:	

Panels shall be fabricated from 0.125-inch thick, 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B 209.



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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. Splicing of retroreflective sheeting shall not be allowed on sign panels having a minimum dimension up to and including four feet.

Messages shall be reflectorized white or, if called for on the plans, opaque black and shall be produced by either silk screening or direct-applying lettering as specified under Subsection 608-2.15.

### **608-2.08           Blank**

### **608-2.09           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-H38 or 6061-T6 Aluminum Alloy conforming to the requirements of ASTM B 209.

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.

Warning signs shall be reflectorized with yellow retroreflective sheeting.

Regulatory signs shall be reflectorized with silver-white retroreflective sheeting.

Reflectorized red signs shall be reflectorized with silver-white retroreflective sheeting. The red color shall be produced by silk screening.

Regulatory signs with reflectorized red circles and slashes shall be reflectorized with silver-white retroreflective sheeting. The red color shall be produced by silk screening.

Interstate route markers shall be cut to shape. The colors and legend shall be as shown on the plans and shall be reflectorized with silver-white retroreflective sheeting. The Interstate route colors shall

be silk screened. The numerals may be silk-screened or direct-applied characters.

United States, State Route, and Cardinal Direction markers shall be reflectorized with silver-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 four feet.

Sign panels shall be attached to the posts with bolts as shown in the plans. A nylon washer, conforming to ANSI Standard and having a diameter two times the bolt head diameter, shall be placed between the bolt head and panel face. Fastening nuts shall be heavy hex; however, standard nuts may be used if a flat wash is placed between the nut and sign posts.

#### **608-2.10           Blank**

#### **608-2.11           Route Shields (For Installation on Sign Panels):**

Route shields shall be cut to shape and shall consist of 0.063-inch thick, 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B 209. The aluminum shall be degreased and etched in accordance with the recommendations of the sheeting manufacturer. Retroreflective sheeting shall be silver-white and shall conform to the requirements of Section 1007. The size of the numerals shall be half the height of the shield.

Route shields shall be attached to the sign panel with self plugging aluminum blind rivets with a 1/4-inch thick nylon spacer on each rivet between the route shield and the sign panel.

#### **608-2.12           EXIT ONLY (For Installation on Sign Panels):**

EXIT ONLY panels shall be fabricated from 0.063-inch thick, 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B 209 with 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.

EXIT ONLY panels shall be attached to the sign panel with self-plugging aluminum blind rivets with a 1/4-inch thick nylon spacer on each rivet between the EXIT ONLY panel and the sign panel.

The letters, arrows, and borders shall consist of black embossed aluminum frames or flat sheet aluminum frames with no reflectors. The height of the letters shall be 12 inches unless otherwise specified in the plans. The panel shall be 36 inches in height unless otherwise specified in the plans.

**608-2.13            Retroreflective Sheeting, Inks and Opaque Film:**

Retroreflective sheeting, sign-making inks, and opaque films shall conform to the requirements of Section 1007.

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 letter and number text shall be of the same type and brand, and shall be installed at a zero-degree orientation.

**608-2.14            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, or 5052 as specified in ASTM B 209. 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 four- to six-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 four 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. 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. Demountable legends on white and yellow background signs shall be black, and shall be opaque and non-reflective. Acceptable finishes for black characters shall be porcelain-enameled black, powder-coated black, or 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 shall be used for white borders. Black borders shall be porcelain-enameled black, powder-coated black, or laminated black opaque acrylic film.

Black porcelain enameling, black powder-coatings, or 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 for such coatings to the Engineer.

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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.

#### **608-2.15      Silk-Screened or Direct-Applied Characters:**

Silk-screened 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

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the manufacturer of the retroreflective sheeting and shall be applied by heat activation of the adhesive.

The retroreflective sheeting used for characters shall meet or exceed the minimum Specific Intensity Per Unit Area (SIA) of the background sheeting.

### **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.

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.

#### **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 five 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.

The heads of bolts on the panel face shall be anodized or painted to match the background or legend color in which they are placed. The nylon washers on the panel face shall be the color of, or shall be painted to match, the background or legend color in which they are placed. The sign manufacturer's name and date of installation shall be placed on the back of each sign in black, one-inch block letters. Use of felt markers for this purpose will not be permitted. 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 two copies of a detailed list of all new signs installed on the project to the Engineer. 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). The list shall be provided in a commonly used electronic spreadsheet format, such as EXCEL, and the two copies shall be submitted on either CD-ROM disks or IBM-formatted 3.5-inch floppy diskettes. 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.

Signs 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 the installation of each finished 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 plans. 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.

Construction signs are exempt from the installation information requirement unless noted otherwise on the project plans.

Bolts shall be tightened from the back of the sign by holding the bolt head stationary on the face of the panel to prevent damage to the sheeting surface.

#### **608-3.03            Miscellaneous Work (Sign Panels):**

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.

#### **608-3.04            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.



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Each sign panel face shall be cleaned thoroughly just prior to the inspection by a method recommended by the manufacturer. The cleaning solvent and 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.

### **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. 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 measured to the nearest square foot and the areas will be determined as follows:

The areas of each rectangular, square or triangular sign panel will be determined from the dimensions shown on the plans.

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.

Miscellaneous Work (Sign Panels) 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.

Payment shall be made on the total area of each type of sign panel to the nearest square foot, except Route Shields and EXIT ONLY (For Installation On Sign Panels) which shall be paid for as part of the overall 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 Miscellaneous Work (Sign Panels), 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 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, as directed or specified, with or without a rock socket or a belled footing, and shall be constructed in reasonably close conformity with the details and dimensions shown on the plans and the requirements of these specifications.

#### **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 at Contracts and Specifications Section, 1651 West Jackson, Phoenix, Arizona.

#### **609-1.03 Installation Plan:**

The contractor shall provide to the Engineer for review and approval a detailed installation plan containing the following information:

- (1) 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.
- (2) Details of overall construction operation sequence and the sequence of shaft construction in bents or groups.
- (3) Details of shaft excavation methods, including equipment and procedures for checking the dimensions and alignment of each shaft excavation.
- (4) When slurry is required, details of the method proposed to mix, circulate and desand slurry, and methods proposed to comply with the requirements of

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Subsections 609-3.04(A) and 609-3.07(C), including disposal of the slurry.

- (5) Details of methods to clean the shaft excavation.
- (6) Details of reinforcement placement, including support and centralization methods, lifting equipment, and staging location for tied steel reinforcement cages prior to placement.
- (7) Details of concrete placement, including concrete volumetric charts.
- (8) Details of casing dimensions, material and splice details.
- (9) Details of concrete mix designs and mitigation of possible loss of slump during placement.
- (10) List of work experience in previous similar projects.
- (11) Other information shown on the plans or requested by the Engineer.
- (12) Emergency horizontal construction joint method if unforeseen stoppage of work or interruption in concrete delivery occurs.
- (13) 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 not later than four weeks before work on shafts is to begin. The Engineer will review the initial submittal within ten 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, light standard and sign post foundations of less than four feet in diameter and 20 feet in length shall be exempt from the requirement to submit an installation plan, conduct a drilled shaft preconstruction meeting, and construct a confirmation shaft.

**609-2 Materials:**

**609-2.01 Concrete:**

Concrete shall conform to the requirements of Section 1006 for the design criteria shown on the plans, with the following additions or modifications:

**(A) Cement:**

Where concrete is placed in drilled shaft excavations containing slurry or water, the cement content of the concrete shall be between 660 and 750 pounds per cubic yard.

**(B) Aggregate:**

Maximum aggregate size shall be limited to 1/5 of minimum clear bar spacing (vertical and horizontal), not to exceed 3/4 inch for drilled shafts constructed with a wet method or with temporary casing (excluding collar-only casings), and one inch for drilled shafts constructed with a dry method.

**(C) Air-Entraining Admixtures:**

Air-entraining admixtures will be required for concrete drilled shafts in all areas where scour is anticipated, as indicated in the geotechnical report. In non-water environments, air-entraining admixtures will be required for concrete drilled shafts when the top of the shaft is less than three feet below finished grade. In either case, when air-entraining admixtures are required, as specified above, the entire drilled shaft shall contain the admixture.

**609-2.02 Reinforcing Steel:**

Reinforcing steel shall conform to the requirements of Section 1003. If approved in writing by the Engineer, Grade 75 steel bars meeting all requirements of these Specifications may also be allowed, at no additional cost to the Department. The contractor's request shall specify whether all bars are to be Grade 75, or mixed with other grades. Welded splices will not be allowed except as shown on the plans.

**609-2.03 Casing:**

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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 M 270 (ASTM A 709), Grade A 36, 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 plus or minus two percent of 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 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 AASHTO Standard Specifications for Highway Bridges, Division II, 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, durable concrete foundation shafts free of defects. 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 directed in writing by the Engineer.

Unless otherwise directed 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 ordered 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 a specific soil strata.

### **609-3.03      Excavation:**

The contractor shall perform all excavation required for the shafts, rock sockets or belled footings, through whatever substances encountered, to the dimensions and elevations shown on the plans or ordered by the Engineer. Unless otherwise shown on the plans, the maximum deviation from plumb shall be not more than one and one half percent. The maximum permissible variation of the design center axis for both the borehole and rebar cage at the top shall be five percent of the shaft diameter, not to exceed three 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 these readings for each drilled shaft constructed to verify plumbness. 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 satisfactory material is not encountered at plan elevation, the bottom of any drilled hole may be lowered, at the direction of the Engineer. Alteration of plan depth will be made to satisfactorily comply with design requirements. Reinforcing steel and concrete shall not be placed in the shaft until this final elevation has been established and the Engineer is satisfied with the completed excavation. Raising of the foundation elevation shall require approval by the Engineer.

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

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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 six inches unless use of telescoping casing or surface casing is allowed by the installation plan.

Adjacent shafts, unless separated by a minimum of three shaft diameters, shall not be drilled 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 as approved by the Engineer.

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, 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.

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 shall provide a manufacturer's representative with experience in the slurry drilling process to design and monitor the slurry. The manufacturer's representative shall be present at all times while the slurry method is under development, and shall supervise the testing required in Subsection 609-3.04(B). Once a method that consistently produces acceptable excavations has been developed and accepted by the Engineer, the contractor may substitute one of its employees for the representative provided that the employee has been suitably trained in the procedure. The contractor shall also ensure that the manufacturer's representative remains available to return to the site and supervise changes to the drilling slurry if needed.

Only commercially prepared mineral slurries or synthetic slurries listed on the Department's Approved Products List 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 mineral slurry in the shaft excavation shall be maintained at a level not less than five feet above the highest expected piezometric pressure head along the depth of the shaft. The level of polymer slurry shall be maintained at or near the ground surface or higher, if required to maintain boring stability. 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 boring. 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 in lieu of slurry tanks. No mixing of slurry shall be allowed in the drilled shaft excavation. 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 and the slurry tested for compliance with Table 609-3.04(A). 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 slurry sand content within the acceptable values shown in Table 609-3.04(A) at any point in the bore hole. Desanding will not be required for setting casing. The contractor shall take all steps



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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 slurry off site at an approved disposal site.

<b>TABLE 609-3.04(A)</b> (Sodium Bentonite in Fresh Water)			
<b>Property; units</b>	<b>Range of Values *</b>		<b>Test Method</b>
	<b>At Time of Introduction of Slurry</b>	<b>In Hole at Time of Concreting</b>	
Density; (pcf)	64.3 - 69.1	64.3 - 75.0**	Density Balance
Yield Point; pascals	Bentonite 1.25 - 10	10 Maximum	Rheometer
Or			
Viscosity; seconds/quart	28 - 50	28 - 50	Marsh Cone
pH	7-12	7-12	pH Paper or pH Meter
Sand Content; % by volume	0 - 4	0 - 2	API Sand Content Kit
* Above 68 degrees F			
** 85 pcf maximum when using Barite.			

### (B) Slurry Inspection and Testing:

The contractor shall have suitable apparatus available at the site capable of obtaining slurry samples at any depth within the drilled shaft excavation. All equipment required for the tests specified in this section shall be provided by the contractor, and the tests shall be performed by the contractor under the observation of the Engineer.

Control tests using suitable apparatus shall be carried out by the contractor on the mineral slurry to determine density, viscosity or yield point, pH and sand content. A range of values for those physical properties is shown in Table 609-3.04(A); but, in all cases, at least the minimum value necessary to achieve borehole stability shall be utilized.

Tests to determine density, viscosity or yield point, and pH value shall be done by the contractor during the shaft excavation to establish a consistent working pattern. A minimum of four sets of tests shall be made during the first eight hours of slurry use. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use.

The contractor shall ensure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft. Prior to placing concrete in any shaft excavation, the contractor shall take slurry samples using a

sampling tool suitable for recovery of slurry samples at any desired elevation in the excavation. Slurry samples shall be extracted from the base of the shaft and at 10 feet up the shaft until samples produce acceptable values for density, viscosity or yield point, pH, and sand content.

When any slurry samples are found to be unacceptable, the contractor shall take whatever action is necessary to bring the slurry within specification requirements. Concrete shall not be placed until resampling and testing results produce acceptable values.

Reports of all tests required above, signed by an authorized representative of the contractor, shall be furnished to the Engineer on completion of each drilled shaft.

### **609-3.05 Integrity Testing:**

Drilled shaft integrity testing shall be performed by the contractor and will be reviewed by the Engineer.

Each drilled shaft foundation completed by a wet excavation method shall be inspected by means of a cross-hole sonic logging survey. The drilled shaft contractor shall furnish and install 2-inch Schedule 80 PVC pipes for cross-hole sonic logging. 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 uniformly distributed along the inside circumference of the reinforcing steel cage. The pipes shall be joined to provide a clean, watertight, and unobstructed opening from the top of the drilled shaft foundation to within one foot of the tip in accordance with the details shown on the plans. The PVC pipes shall be capped on the bottom and filled with water prior to concrete placement. The pipes shall be securely tied to the reinforcing steel in a straight line to prevent displacement during handling and concrete placement, and to permit the logging device to pass from top to bottom.

The contractor shall provide the testing equipment, perform the inspection, and furnish test results to the Engineer. The contractor shall also provide documentation that the testing equipment has been calibrated and is functioning properly. Integrity testing shall be performed no sooner than 48 hours after placement of the concrete, and all testing shall be finalized within seven days of placement.

Readings from the cross-hole sonic logging shall be taken with a maximum interval of two inches, and shall include all possible ray paths. The contractor shall provide an inspection report that contains the acquired raw data, and an evaluation report prepared and sealed by a registered professional engineer. Graphs of acoustic pulse arrival time versus depth and power of the arriving signal versus depth in each pair of tubes shall be provided. All reports shall be provided to the Engineer within three days of test completion.

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If the testing indicates the presence of voids, intrusions or zones of unconsolidated concrete in the drilled shaft foundation, or if the Engineer determines that construction defects may have occurred, the contractor shall conduct three-dimensional tomographic surveys of the anomalies, 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 defects in the concrete as approved by the Engineer. The contractor shall repair, replace, or supplement the defective work in a manner approved by the Engineer, which may include constructing one or more additional drilled shafts at the locations directed by the Engineer, at no additional cost to the Department.

Concrete volumetric charts shall be completed for every drilled shaft.

After all inspection has been completed, all holes and test pipes in all drilled shaft foundations shall be filled with an approved grout from the bottom up.

### **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 in writing 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 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. Spacers shall be at sufficient intervals along the shaft to ensure concentric location of the reinforcing cage for the entire length of shaft. Spacers shall be placed at a maximum vertical spacing of 15 feet, with a minimum of four spacers around the circumference at each vertical elevation. For all drilled shafts of less

than six feet in diameter, the spacers shall provide for a minimum of three inches of concrete cover between the reinforcing steel and the excavation wall. For all drilled shafts of six feet in diameter or greater, or for drilled shafts of any diameter constructed with the wet method, the spacers shall provide for a minimum of six inches of concrete cover between the reinforcing steel and the excavation wall. Only spacers approved by the Engineer shall be allowed, and in no case shall "dobies" or other rectangular "blocks" tied to the reinforcing steel be allowed in excavations with the wet method. When "dobies" are used, they shall be made from concrete of the same compressive strength as the concrete used in the drilled shafts.

If the shaft is lengthened and the plans indicate full depth reinforcement, the Engineer shall be notified to determine if extension of the reinforcement is needed. The Engineer will provide details for additional reinforcing if required. Such additional reinforcing will be paid for in accordance with Subsection 109.04.

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 and as specified herein. If slurry excavation is used, concrete shall be placed the same day the excavation is completed. Unless otherwise specified in the project documents, or as directed by the Engineer, the slump shall be five  $\pm$  one inches for dry, uncased excavations. For all others, the concrete slump shall be eight  $\pm$  one inches at the time placement begins.

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. During concrete placement, from start to finish, the rate of rise of the top of concrete in the drilled shaft shall be at least 40 feet per hour.

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

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least ten inches for all drilled shafts four feet or greater in diameter. The inside diameter of the pump pipe shall be at least five inches.

The concrete mix shall remain in placement for at least two hours before obtaining the initial set as determined in AASHTO T 197 (ASTM C 403).

### **(B) Placement in Dry Excavations:**

For placement in dry excavations, concrete may be placed by free fall except in fragile, cohesionless 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 three 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).

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 five feet below the surface of the concrete at all times for shaft diameters less than six feet, and deeper than ten feet below the surface of the concrete for shaft diameters six 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 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 five 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 ten 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 four inches. The contractor shall maintain a minimum five-foot head of concrete for shaft diameters of less than six feet, and a minimum ten-foot head of concrete for shaft diameters six 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 one 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.

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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 linear foot for the diameter designated in the bidding schedule, complete in place, including 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; conduit and equipment for sonic cross-hole logging; and all required tests. No additional payment will be made for metal casing that is to remain in place. No additional payment will be made for confirmation shafts or for providing a manufacturer's representative for the drilling slurry, the costs 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. Drilling tools which are lost in the excavation shall not be considered obstructions. Payment for obstructions will be made in accordance with the provisions of Subsection 109.04.

## **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 these 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, 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 mils 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.



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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 or 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, or 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 contaminants 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 PSI and not greater than 5000 PSI. The water blasting equipment shall have a minimum water usage of 5 gallons/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 D 4259. 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 workmanlike manner.

For painting metal surfaces, paint shall normally be applied by spraying with limited use of hand brushes or rollers except that aluminum paint, as specified in Subsection 1002-2.03, shall be applied by spraying.

For painting concrete surfaces, the contractor shall develop an Application Plan according to the manufacturer's written recommendations. The Plan shall include:

- (1) Rate of application.
- (2) Number of necessary coats (minimum of two coats).
- (3) Ambient air temperature.
- (4) Ambient surface temperature.
- (5) Application equipment.
- (6) Qualification of workers.
- (7) Safety and damage protection.
- (8) 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. For paints not on the Approved Products List, a test specimen will be used for testing the performance requirements indicated in Section 1002.

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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 or paint stains which result 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.

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 primer shall conform to the requirements of Subsection 1002-2.01. 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 three 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 primed 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 and shall conform to the requirements of Subsection 1002-2.01. 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. 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:**

The topcoat shall conform to the requirements of Subsection 1002-2.01.

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, acrylic emulsion paint conforming to the requirements of Subsection 1002-2.04, 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 one 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:**

Areas of galvanized coating damaged due to welding after fabrication or due to handling, shall be roughened by sanding or acid and the roughened areas shall be painted with at least one full coat of zinc paint, conforming to the requirements of Subsection 1002-2.02.

**610-4                Blank**

**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, 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 VI 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.

When a traffic control plan is included in the project plans, this plan 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 approval a proposed sequence of operations and a compatible method of maintaining traffic. The 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.
- (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 Subsection 106.05(B)(5).

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 Federal Highway Administration (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



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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 letter certifying that any temporary concrete barrier used on the project conforms to Signing and Marking Standard Drawing C-3. The letter shall also include the project number, and the name, title, and signature of a person having legal authority to bind the manufacturer or supplier of the attenuation devices. The binding authority shall be in accordance with Subsection 106.05(B)(5).

#### **701-2.04 Temporary Impact Attenuation Devices:**

Temporary impact attenuation devices shall conform to the requirements of Subsections 702-2 and 702-3 of these 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 III per NCHRP (National Cooperative Highway Research Program) Report 350. The contractor shall provide, at the preconstruction conference, a letter certifying that all temporary impact attenuation devices meet the above requirement. The letter shall also include the project number, and the name, title, and signature of a person having legal authority to bind the manufacturer or supplier of the attenuation devices. The binding authority shall be in accordance with Subsection 106.05(B)(5).

## **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 these 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:

	<b>Requirement</b>	<b>ASTM Test Method</b>
Specific Gravity (Min.)	1.19	D 792
Hardness (Min.)	80A	D 2240
Tensile Strength (Min. PSI)	4,600	D 412
Ultimate Elongation (Min. %)	330	
Modulus @ 300% PSI	1,000	
Stiffness @ -20 °F (Min. PSI) 70 °F (Min. PSI)	17,000 900	D 1053
Compression Set 22 hrs. @ 70 °C	65	D 395
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

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have a minimum reflectance equal to or greater than 1,800 candelas per foot-candle per square foot at 0.10-degree observation and zero-degree entrance angles.

### **(B) Pavement Marking Paint:**

Paint for temporary striping, arrows, symbols and legends shall be white or yellow and shall conform to the requirements for permanent striping paint as set forth in Section 708 of these specifications and as indicated on the project plans or as approved by the Engineer. Paint for temporary symbols and legends shall be white and shall meet the same requirements as temporary striping.

### **(C) 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 these 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 these specifications.

### **701-2.08 Barricades:**

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 shall be a minimum of Type II sheeting, conforming to AASHTO M 268.

### **701-2.09 Drums:**

Sheeting type for drums shall conform to the requirements for work zone devices shown in Section 1007.

### **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.

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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 these 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 these 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:

- (1) When hit, the device shall not penetrate the passenger compartment of the errant vehicle or present a hazard to workers and other traffic.
- (2) The device shall perform in a predictable manner when hit.
- (3) The device shall effectively reduce glare from oncoming vehicle head lights.
- (4) 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 conforming to the requirements of Subsection 702-2.02 of these specifications shall be installed at the locations and in accordance with 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 these specifications shall be placed in accordance with the details shown on the project plans.

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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 these 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 these 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.

On intermediate lifts of overlay projects, pavement marking for temporary striping shall consist of four-inch wide by four-foot long strips of reflective material, either pavement marking tape or traffic paint, placed at 40-foot intervals. In situations involving severe degree of curvature, the Engineer may direct that the length and spacing be adjusted to two feet and 20 feet, respectively. These requirements apply to white lane lines separating traffic moving in the same direction and to yellow centerlines for two-lane, two-way roadways in areas where passing is permitted. Temporary pavement marking shall be placed on each subsequent pavement course.

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 Types II (Temporary-Removable) and III (Temporary-Nonremovable)

and shall conform to the requirements of Subsection 705-3 of these 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. Temporary pavement marking paint may also be used where removal of markings is not required unless otherwise shown on the project plans or in the Special Provisions.

### **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 two feet in width.



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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.

### **701-3.07      Truck-Mounted Attenuator:**

Trucks and truck-mounted attenuators shall be furnished by the contractor at the locations shown on the project plans and/or as directed by the Engineer.

Trucks shall be highway maintenance service trucks weighing between 10,000 and 24,000 pounds. Trucks equipped with truck-mounted impact attenuators shall be furnished with shoulder and lap restraint safety belts for both driver and passenger seats. All truck-mounted attenuators shall meet NCHRP 350 requirements. The attenuators shall consist of three basic components:

- (1) A back-up support structure for attaching the back-up to the truck;
- (2) A back-up; and
- (3) A crushable cartridge containing an energy absorbing material.

The dimensions of the attenuator shall be approximately seven feet long, two feet high and eight feet wide, and the total weight of the attenuator shall be approximately 1,000 pounds.

Attenuators shall have rear-mounted, black and high-intensity yellow chevron stripes and a standard trailer lighting system, including brake lights, turn signals, ICC-bar lights, and two yellow rotating beacons mounted on opposite rear corners of the truck approximately 4-1/2 feet from ground level. When the attenuator is in position, roadway clearance shall be between 10 and 12 inches. The attenuator shall be designed to provide for quick and simple connection to the truck.

When impacted head-on at 45 miles per hour, the truck-mounted attenuator shall perform as follows:

- (1) For impacting vehicles weighing from 1,800 to 4,500 pounds, the average over-all longitudinal deceleration shall be less than 12 g's; the two-foot flail space velocity shall be less than 40 feet per second; and the

roll-ahead distance of the truck, with wheels locked and parking brake set, on clean, dry pavement, shall be less than 15 feet.

- (2) For impacting vehicles weighing up to 1,800 pounds, the average over-all longitudinal deceleration shall be less than 15 g's; the two-foot flail space velocity shall be less than 40 feet per second; and the roll-ahead distance of the truck, with wheels locked and parking brake set, on clean, dry pavement, shall be less than 10 feet.

The contractor shall keep the attenuator bright and clean for maximum visibility.

The contractor shall cease operations when a truck-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 power supply shall be either an internal combustion engine generator or batteries which are recharged 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.

For changeable message boards using electromagnetically actuated reflective dots or for non solar-powered LED changeable message boards, the contractor shall submit, at the pre-construction conference, a Certificate of Compliance that the message board to be used on this project shall be as described herein.

The Department's Approved Products List (APL) provides a list of approved solar-powered LED changeable message boards which may be used in the performance of this work. For other solar-powered LED changeable message boards, the contractor shall submit, at the pre-construction conference, a Certificate of Compliance that the

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message board to be used shall be as described herein. Copies of the most recent version of the APL are available on the internet from the Arizona Transportation Research Center (ATRC), through its PRIDE program.

The character formation system and components shall conform to the following requirements:

- (1) The changeable message board shall have a minimum of three separate lines with eight characters per line.
- (2) The changeable message board matrix configuration shall be 35 dots or pixels per character in a five horizontal by seven vertical arrangement of the dots or pixels.
- (3) The dot or pixel size shall be a 2.5-inch high by 1.625-inch wide rectangle (minimum), or equivalent area.
- (4) Each character shall be 18 inches in height and 12 inches in width (minimum).
- (5) The horizontal character separation shall be three inches or more.
- (6) 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.
- (7) The line separation shall be five to 12 inches.
- (8) 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.
- (9) The programmable message board shall be capable of displaying moving arrow patterns as one of the operator-selected programs.
- (10) The programmable message board 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.
- (11) The message board shall also be capable of displaying a minimum of four messages in sequence, with variable timing in a minimum of quarter-second increments.

- (12) 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.
- (13) The power supply achieved from an internal combustion engine generator shall be capable of operating the changeable message board for 72 continuous hours without refueling.
- (14) 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 eight feet from the nearest traffic lane. Where possible, a 20-foot or more offset shall be used. When positioned on the highway, a minimum of ten 28-inch reflectorized traffic cones shall be set around the sign unit at a spacing of up to 10 feet.

When not in operation, the changeable message board shall be turned away from oncoming traffic.

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.

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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 orange warning signs, as defined in Part 6 of the MUTCD, and for specialty signs as defined herein, shall be orange fluorescent prismatic sheeting. Orange sign sheeting shall conform to the requirements of Section 1007.

Sign sheeting for other signs shall be Type III/IV, and shall conform to the requirements of Section 1007.

### **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 either civilian, local enforcement officers and their vehicles, or DPS (Department of Public Safety) officers and their vehicles. The Engineer will determine the type of flagger needed, and may adjust the relative number of hours of each type of flagger specified in the traffic control plan.

If available, only DPS officers shall be used on Interstate Highways and Urban Freeways. DPS officers shall also be used on other construction projects except when a local agency has jurisdiction, in which case a local law enforcement officer and vehicle shall be used.

The Engineer will make all the necessary arrangements to procure DPS flagging services. The contractor shall notify the Engineer a minimum of three working days prior to the start of any operation involving DPS officers for flagging.

Procurement of civilian flaggers, or local enforcement officers used for flagging, will be the responsibility of the contractor.

For operations in which DPS officers are to be used for flagging, the contractor shall be responsible to notify the Engineer a minimum of six hours in advance of any operation which is to be canceled. Should such notification not be received as specified, and DPS officers are dispatched to provide flagging services for the canceled operation, a charge of \$70.00 per DPS officer will be deducted from the monies due the contractor.

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.

A local enforcement officer shall not work more than 12 consecutive hours 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 must be approved by the Engineer. Flagger certification must

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be current. Training and certification shall be required at least once every two 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 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 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 for Temporary Concrete Barrier (Installation and Removal), and Subsection 701-5.02 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) 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) 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. 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).

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) 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



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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) 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) 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) 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 702-4.01(B). 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) 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). 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. 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, will be measured by the day for each 24-hour day that a truck-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 local enforcement officers will be measured for each hour that a uniformed, off-duty law enforcement officer with police vehicle is employed directly by the contractor as a flagger, when authorized in advance by the Engineer. No measurement will be made when DPS officers and their vehicles are used to provide flagging services.

Civilian or local enforcement flagging services and traffic control required to permit contractors' traffic to enter safely into normal traffic within the project limits will be paid under this item. Flaggers required by a written local permit agreement will be measured for payment under this item. Additional civilian or local enforcement flagging services

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used within the project limits shall be measured for payment under this item, subject to the approval of the Engineer.

Civilian or local enforcement flagging services and traffic control devices used outside the project limits will be measured under this item. 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.

The contractor shall be responsible for obtaining and paying all costs for local enforcement officers and vehicles.

- (G) Temporary Preformed Markings for Pavement, Types II and III, will be measured in accordance with the requirements of Subsection 705-4 of these specifications.
- (H) Temporary Painted Markings for Pavement will be measured in accordance with the requirements of Subsection 708-4 of these specifications.
- (I) Obliterate Pavement Marking will be measured in accordance with the requirements of Subsection 708-4 of these specifications.
- (J) Changeable Message Boards will be measured by the day for each 24-hour day that the sign is utilized to maintain and control traffic.
- (K) Obliterate Pavement Markers will be measured for each unit, Markers and Adhesive pad, or Adhesive pad alone where Markers are missing.
- (L) 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.
- (M) 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) and approved by the Engineer.

- (N) 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.

- (O) 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, 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.

Should it be necessary to dismantle, pick up and relocate a portion of the barrier installation a lateral distance of more than 12 feet during construction, that portion of the removed and relocated barrier will be considered a new installation and measured for payment at the contract unit price.

For a lateral movement of 12 feet or less, or any vertical movement, the contractor will be paid for 50 percent of the length of the relocated Temporary Concrete Barrier (Installation and Removal), provided the contractor can demonstrate, to the Engineer's satisfaction, that it is not possible to move the barrier without dismantling and lifting. No payment will be made for portions of the barrier which the contractor can relocate without dismantling and picking up.

**701-5.02 Temporary Impact Attenuators (Installation and Removal):**

Temporary Impact Attenuation Devices shall include Sand Barrels and Energy Absorbing Terminals, measured as provided above, and 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.

Should it be necessary to dismantle, pick up and reinstall attenuation devices during construction, for use on the project site, the work of removing and reinstalling the devices will be measured for payment as a new installation.

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 bid item price paid for Temporary Impact Attenuator "In-Use."

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 these 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 these specifications.

#### **701-5.04 Temporary Painted Pavement Markings:**

The accepted quantities of Temporary Painted Markings, Symbols, Arrows, and Legends, 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 glass beads.

#### **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, except that, for decreases in quantities, the following items will be considered as major items:

- (1) Temporary Concrete Barrier (In-Use);
- (2) Barricades; and
- (3) 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 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.

**(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.



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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, measured as provided above, will be paid for at the unit bid price per day of work site protection, which rate shall be full compensation for the work, complete, including, but not limited to, furnishing all materials, equipment and labor (including the operator) and maintaining and repairing the truck and truck-mounted attenuator as specified herein and on the project plans. It shall be the contractor's responsibility to replace any damaged or destroyed parts of the attenuator 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, 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, including incidental grading; traffic cones; and furnishing, operating, maintaining, and relocating the boards on the work site, and providing all necessary labor and equipment. No payment will be made for incidental grading or traffic cones, the cost being considered a part of contract items.

### **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 including, but not limited to, furnishing and maintaining the vehicle and furnishing the driver. Overtime hours for pilot vehicles will be paid for at the unit bid price for pilot vehicle with driver. No additional payment will be made for overtime hours, the cost being considered as included in the unit bid price.

The accepted quantities of flagging services provided by the local enforcement officers and civilian flaggers, measured as provided in Subsection 701-4.04(F), will be paid for at the unit bid price, which price shall be full compensation for the work, complete, including all overhead costs and fringe benefits. Overtime hours for local enforcement officers and civilian flaggers will be paid for at the respective unit bid prices. No additional payment will be made for overtime hours, the cost being considered as included in the unit bid price for local enforcement officers and civilian flaggers.

No payment will be made when DPS officers and their vehicles are used to provide flagging services.

#### **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 attenuation devices of the types and at the locations and in accordance with the details shown on the project plans and the requirements of these 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.

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Materials used in transitions or connections between impact attenuators and metal-beam guardrail shall conform to the requirements of Section 1012.

Materials used in transitions or connections between impact attenuators and concrete structures or barriers shall conform to the applicable requirements of Subsection 910-2, except anchors and anchor bolts shall conform to the requirements of Section 1012.

Concrete shall be utility concrete conforming to the requirements of Section 922. Steel reinforcement shall conform to the requirements of Section 1003.

Asphaltic concrete shall conform to the requirements of Section 406.

Attenuation devices approved for use are 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 PRIDE program. Attenuation devices other than those listed on the APL shall be approved by the Department prior to use.

### **702-2.02      Energy-Absorbing Terminal:**

Energy-absorbing terminals shall be multiple bin units of collapsible cartridges positioned between diaphragms that are enclosed by a framework of the beam guardrail fender panels conforming to the details shown on the project plans.

### **702-2.03      Sand Barrel Crash Cushion:**

Sand barrel crash cushions shall be frangible, plastic modules formulated or processed to resist deterioration from ambient ultraviolet rays. The color of the outer module or stabilizer and lids shall be the standard gray or yellow color as furnished by the vendor.

The modules shall exhibit good workmanship free from structural flaws and objectionable surface defects. The Engineer may measure the thickness of the inner module and stabilizer walls as shown on the plans by any means the Engineer considers appropriate. When filled with the specified weight of sand, the module walls shall not distort, either as an indentation or a protrusion, more than 1/2 inch from the original module wall configuration.

Modules shall be filled to the designated height with sand (fine aggregate) meeting the requirements of Subsection 1006-2.03 (B). The sand, when placed in the module, shall have a dry unit weight of from 80 to 105 pounds per cubic foot and a moisture content of less than two percent, by weight.

Sand barrel crash cushion installations at elevations above 3,000 feet shall have five percent rock salt (by weight) mixed with the sand.

**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, when the plans require the attenuation device to be placed on a paved pad, the pavement shall be four inches thick and shall be made either of utility concrete or asphaltic concrete, at the option of the contractor. The soil under the pad, or under the impact attenuator when no pad is required, 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.

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### **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 plans 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 shall be submitted.

##### **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.

##### **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 B 209.

##### **703-2.05 Paint:**

Paint for use on the metal plates shall conform to the requirements of Section 1002 for the type and color of paint specified on the plans.

##### **703-2.06 Retroreflective Sheeting:**

Retroreflective sheeting for delineators and markers shall conform to the requirements of Section 1007.

The type of retroreflective sheeting to be applied shall be as specified on the plans.

##### **703-2.07 Prismatic Reflectors:**

Prismatic reflectors for delineators and markers shall conform to the requirements of Section 1008.

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 A 153 or shall be cadmium plated in accordance with the requirements of ASTM B 766.

**703-3 Construction Requirements:**

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 three (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.

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).

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.

**703-4 Method of Measurement:**

Delineators and markers will be measured by the unit for each type of delineator and marker furnished and installed.

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### **703-5 Basis of Payment:**

The accepted quantities of delineators and markers, measured as provided above, will be paid for at the contract 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.

## **SECTION 704 THERMOPLASTIC PAVEMENT MARKINGS:**

### **704-1 Description:**

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, ribbon or spray 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.

### **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 internet from the Arizona Transportation Research Center (ATRC), through its PRIDE program.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

#### **704-2.02 Composition:**

The thermoplastic composition shall conform to the following requirements:

	Percent by Weight	
	White	Yellow
Binder (hydrocarbon or alkyd)	18 - 26	18 - 26
Titanium dioxide	10 - 15	-----
Basic lead chromate	-----	2 - 10
Reflective glass inter-mix beads	30 - 40	30 - 40
Calcium carbonate or equivalent filler	20 - 40	25 - 45

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 shall be one of the following two types based on the binder composition:

**Hydrocarbon:** Shall consist mainly of synthetic petroleum hydrocarbon resins with appropriate fillers and pigments.

**Alkyd:** 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 eight percent by weight of the entire material formulation shall be solid maleic-modified glycerol ester resin. The alkyd binder shall not contain any petroleum-based hydrocarbon resins.

An alkyd thermoplastic formulation shall be used for all symbols, legends, and transverse lines, including stop bars and crosswalks. Either an alkyd or hydrocarbon thermoplastic formulation may be used for longitudinal lines, including lane lines and edge lines, unless otherwise shown on the project plans or specified herein. Extrusion or spray formulations shall be used in accordance with requirements of the application equipment used to install the markings.

#### **(A) 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, immediately after application, at a minimum rate of 10 pounds of glass beads per 100 square feet of line (300 linear feet of four-inch stripe).

#### **(B) Filler:**



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The filler shall be a white calcium carbonate or equivalent filler with a compressive strength of at least 5,000 pounds per square inch.

### **(C) Titanium Dioxide:**

Titanium Dioxide shall conform to the requirements of ASTM D 476 for Type II (92 percent).

### **(D) Lead Chromate Pigment:**

The lead chromate pigment shall be silica double encapsulated heat resistant lead chromate pigment.

## **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  $\pm$  five minutes at  $425 \pm$  three degrees F and cooled to  $77 \pm$  three 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:**

The white and yellow thermoplastic materials shall have the following minimum retroreflectance values at 86.5 degrees illumination angle and 1.5 degrees observation angle as measured by a Mirolux 12 portable retroreflectometer or similar approved device within 30 days after application to the roadway surface:

<b>Product</b>	<b>Retroreflectance (millicandelas)</b>
White	200
Yellow	125

**(D) Softening Point:**

After heating the thermoplastic material for four hours  $\pm$  five minutes at  $425 \pm$  three degrees F and testing in accordance with ASTM D 36, the thermoplastic materials shall have a softening point of  $215 \pm 15$  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 D 570.

The specific gravity of the material, as determined by Section 11 of AASHTO T 250, shall be between 1.85 and 2.3.

**(F) Impact Resistance:**

After heating the thermoplastic material for four hours  $\pm$  five minutes at  $425 \pm$  three degrees F and forming test specimens, the impact resistance shall be not less than 10 inch-pounds when tested in accordance with Section 9 of AASHTO T 250.

**(G) Bond Strength:**

After heating the thermoplastic material for four hours  $\pm$  five minutes at  $425 \pm$  three 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 Section 7 of 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 0.125 inches on a four-inch square monel panel (thickness  $0.050 \pm 0.001$  inches), on which a suitable primer has been previously applied, and subjecting it to 200 revolutions on a Taber Abraser at  $25^{\circ}\text{C}$ , using H-22 calibrated wheels weighted to 250 grams. The wearing surface shall be kept wet with distilled water throughout the test.

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The maximum loss of thermoplastic material shall be 0.5 grams.

### **(I) Cracking Resistance at Low Temperature:**

After heating the thermoplastic material for four hours  $\pm$  five minutes at  $425 \pm$  three degrees F, applying to concrete blocks, and cooling to  $15 \pm$  three 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 Section 8 of AASHTO T 250.

### **(J) Flowability:**

After heating the thermoplastic material for four hours  $\pm$  five minutes at  $425 \pm$  three degrees F, and testing for flowability in accordance with Section 6 of 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 Section 4 of AASHTO T 250.

### **(L) Flowability (Extended Heating):**

After heating the thermoplastic material for eight  $\pm$  1/2 hours at  $425 \pm$  three degrees , with stirring the last six hours, and testing for flowability in accordance with Section 12 of 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 when tested in accordance with the requirements of ASTM D 92.

### **(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.

**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, except as noted herein.

The inter-mix beads shall conform to AASHTO M 247-81 (1986), type I, 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.

If recommended by the manufacturer, the drop-on beads shall have an adherence coating.

**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 conveying portion of the equipment, between the kettle and the line dispensing device shall be configured to prevent accumulation and clogging, and shall maintain the material at the specified application temperature. The dispensing device shall be capable of applying the required shapes and thicknesses. All parts of the equipment which will

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come in contact with the material shall be constructed for easy accessibility for cleaning and maintenance.

All melting and application equipment shall have functioning and calibrated temperature sensing devices to verify that temperature requirements are being met. The contractor shall provide proof that the temperature sensing devices and verification thermometers are fully functional.

The application equipment to be used on roadway long line installations shall consist of either truck-mounted units or motorized ride-on equipment. The truck-mounted or motorized ride-on units used for center lines, lane lines, gore lines, and edge lines shall consist of a mobile self-contained unit carrying its own material capable of operating at a minimum speed of five miles per hour while applying striping, and shall be sufficiently maneuverable to install curved and straight lines, both longitudinally and transversely.

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.

A glass bead top dressing shall be applied to the completed thermoplastic stripe by an automatic glass bead dispenser attached to the striping machine in such a manner that the beads are applied to the molten thermoplastic material immediately after it has been applied to the pavement. The bead dispenser shall use pressure-type spray guns for truck-mounted or motorized ride-on units, and a drop-on bead dispenser for hand applicators. 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 shall dispense the beads in such a manner that they shall be embedded in the surface of the molten thermoplastic to an anchoring

depth of from 55 to 60 percent of the bead diameter. The bead dispenser 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:**

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 two to four 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:

- Nature, type, and formulation of the material, including whether it is an alkyd or hydrocarbon;
- Manufacturer, batch number, and date of manufacture;
- Application requirements and constraints; and
- Compatibility requirements and constraints, particularly those pertaining to equipment, storage, and other materials to be used.

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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. The contractor shall completely clean preparation and application equipment when materials are changed.

The contractor shall dispose of excess 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 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, grease, oil, 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 two 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:**

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.

The contractor shall measure pavement surface temperatures one half hour prior to the start of the striping installation activities and as deemed necessary by the Engineer until the end of the application period. For elevation changes greater than 1,000 feet, temperature readings at the highest elevation shall govern unless otherwise directed by the Engineer. The lowest temperature so measured shall govern, unless otherwise directed by the Engineer. The temperature measurements shall be recorded in a log book and provided to the Engineer when required. The pavement surface temperature shall be measured with a standard surface temperature thermometer or a non-contact infrared thermometer.

**(G) Thermoplastic Application:**



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The thermoplastic pavement marking material shall be extruded or sprayed on to the pavement surface at a material temperature between 400 and 440 degrees, 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 alkyd and hydrocarbon 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.

Specified temperature requirements shall be maintained at all times during application. The contractor shall monitor material temperature at thirty minute intervals, unless otherwise directed by the Engineer, and maintain a log of temperature readings taken. Readings shall be taken at the melting kettle or the application outlet point, as determined by the Engineer.

The contractor shall minimize the thermoplastic material remaining in the kettle at the end of the work day and shall blend a minimum of 80 percent fresh material the start of each day. During project delays, the contractor may transfer heated thermoplastic material into approved containers for later re-use, subject to specified limits on total acceptable heating time for each batch.

Drop-on glass beads shall be mechanically deposited, at the specified rate, into the thermoplastic material immediately after the thermoplastic marking is applied. The bead dispenser shall evenly distribute the beads such that they embed 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. All markings which do not meet the requirements of Subsection 704-2.03(C), as determined by the Engineer, shall be removed by the contractor and replaced at no additional cost to the Department.

Unless otherwise specified, thermoplastic pavement markings for legends and symbols, and for crosswalks, stop bars and other transverse elements, shall be extruded, and shall be  $0.090 \pm 0.002$  inches thick. Longitudinal markings, such as edge lines, lane lines, gore lines, and other markings parallel to traffic, shall be sprayed thermoplastic, and shall be  $0.060 \pm 0.002$  inches thick. Longitudinal markings of approximately 200 feet or less may be extruded, and shall be a minimum of  $0.060 \pm 0.002$  inches thick. The thermoplastic

thickness shall be uniform and consistent throughout the total length of the marking project.

The contractor shall perform periodic spot checks of thermoplastic material to verify that the required thickness has been attained. 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 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.

The finished thermoplastic line shall have well defined edges and be free from waviness. Lateral deviation of the thermoplastic line shall not exceed one inch in 100. The longitudinal deviation of a painted segment and gap shall not vary more than six 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:

<b>Plan Width</b>	<b>Actual Width</b>
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 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  $412.5 \pm 12.5$  degrees F and thickness range of 0.060 to 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  $50 \pm$  three degrees F and not more than 10 minutes when the air and road surface temperatures are approximately  $90 \pm$  three degrees. The Engineer may conduct field tests in accordance with ASTM D 711 to verify actual drying times.

**704-4 Method of Measurement:**

Thermoplastic pavement longitudinal and transverse markings, such as edge lines, lane lines, gore lines, cross-walks and stop bars, will be measured by the linear foot along the center line of the pavement marking line and will be based on a four-inch-wide line. Measurement for striping with a plan width greater or less than the basic four 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 four-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 four 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, which is to be applied to both old and new Portland cement concrete pavement prior to application of thermoplastic marking, shall 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.

**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 PLASTIC PAVEMENT MARKING:**

### **705-1 Description:**

The work under this section shall consist of furnishing all materials, preparing the pavement surface and applying preformed reflectorized pavement marking tape, arrows and legends to the pavement in accordance with the details shown on the project plans and the requirements of these specifications.

Preformed pavement marking tape, arrows and legends shall be limited to the following applications unless otherwise specified in the contract documents:

#### **(A) Preformed Pavement Markings - Type I (Permanent):**

Type I shall be a general purpose high durability retroreflective pliant polymer film for preformed striping and markings to be used for finished permanent 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.

#### **(B) Preformed Pavement Markings - Type II (Temporary - Removable):**

Type II shall be a removable preformed retroreflective pavement marking capable of performing for the duration of a normal construction season. It shall be a nonmetallic mixture of high quality 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.

#### **(C) Preformed Pavement Markings - Type III (Temporary - Nonremovable):**

Type III shall be a nonremovable preformed retroreflective film on a conformable metallic backing capable of performing for the duration of

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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.

### **705-2 Materials:**

#### **705-2.01 Preformed Pavement Markings - Type I (Permanent):**

##### **(A) General:**

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

Type I preformed plastic pavement marking material shall consist of a homogeneous, extruded, pre-fabricated white or yellow thermoplastic film of specified thickness and width that shall be capable of being affixed to nonbleeding bituminous or Portland cement concrete. It shall contain reflective glass beads uniformly distributed throughout the entire cross section and bonded to the top surface of the material. The preformed plastic film shall be weather resistant and through normal traffic wear shall show no appreciable fading, lifting, or shrinkage or significant tearing, roll back, or other signs of poor adhesion throughout the useful life of the marking.

When extruded, the plastic film without adhesive shall be a minimum of 0.060 inch thick. The plastic film as supplied shall be of good appearance, free of cracks and discolorations, and the edges shall be clean-cut and well defined. The plastic film may be supplied complete with a precoated, factory-applied pressure sensitive adhesive backing with a protective release paper, or it may be furnished with separate adhesive as recommended by the manufacturer. Whether the adhesive is precoated or supplied separately, the adhesive shall be such as to allow the plastic film to be repositioned on the pavement surface to which it is applied before permanently fixing it in its final position with a downward pressure.

A list of approved manufacturers and distributors for Type I (permanent) preformed pavement marking material are shown on the Department's Approved Products List (APL). Copies of the most recent version of the APL are available on the internet from the Arizona Transportation Research Center (ATRC), through its PRIDE program.

##### **(B) Composition Requirements:**

The preformed plastic pavement marking material shall consist of the following components:

<b>Minimum Percent by Weight</b>	
Resins and Plasticizers	20
Pigments	30
Reflective Glass Beads	20

**(C) Physical Requirements:**

**(1) Color:**

The pigments shall be selected and blended to provide a white or yellow marking film which conforms to standard highway colors throughout the expected life of the film.

**(2) Bend Test:**

The plastic film 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), three by six inches in size, may be bent over a one-inch mandrel until the end faces are parallel and one inch apart without showing any fracture lines in the uppermost surface.

**(3) Tensile Strength:**

The plastic film (without adhesive or paper backing) shall have a minimum tensile strength of 40 pounds per square inch when a specimen six inches long by one inch wide is tested in accordance with the requirements of ASTM D 638. 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 six-inch long by one-inch wide section of the plastic film (without adhesive and paper backing) shall support a dead load weight of four pounds for not less than five minutes at a temperature between 70 and 80 degrees F.

**(5) Abrasion Resistance:**

The plastic film shall have a maximum loss in weight of 0.25 grams in 500 revolutions when abraded according to Federal Test Method Standard No. 141, Method 6192, using H-18 calibrase wheels with a 1000-gram load on each wheel.

**705-2.02 Preformed Pavement Markings - Type II  
(Temporary - Removable):**

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Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

Type II preformed pavement markings shall be a non-metallic mixture of conformable materials and pigments intended for marking applications where removability is required. The marking material shall be white or yellow retroreflective film conforming to standard highway colors with glass beads in a reflective layer bonded to the top surface. The glass beads shall meet the durability and reflectance criteria specified in Subsection 705-2.04.

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, 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 roll-up 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.

When extruded, 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):**

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

Type III preformed pavement markings shall be a retroreflective film 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 and shall contain glass beads meeting the durability and reflectance criteria specified in Subsection 705-2.04.

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, roll back or other signs of poor adhesion throughout the useful life of the marking.

#### **705-2.04 Reflective Glass Beads:**

##### **(A) General Requirements:**

The beads shall be manufactured from glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

During manufacture of the preformed plastic pavement marking material, reflective glass beads shall be mixed into the material in the amounts indicated. A layer of reflective glass beads shall be bonded to the top surface of all types of preformed pavement marking materials.

##### **(B) Physical Requirements:**

###### **(1) Roundness:**

The roundness of the glass beads shall be determined in accordance with the requirements of ASTM D 1155. 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) Index of Reflection:**

The glass beads used with the preformed pavement marking material shall have a reflective index of not less than 1.50 when tested by the liquid immersion method at 25 °C.

###### **(3) Gradation:**

The size of the glass beads shall be such that performance requirements for the preformed pavement marking material shall be met.

###### **(4) Chemical Resistance:**

The glass beads shall withstand immersion in water and acids without undergoing noticeable corrosion or etching and shall not be darkened nor otherwise noticeably decomposed by sulfides. The test for chemical resistance shall consist of placing three- to five-gram portions of the sample in each of three pyrex glass beakers or porcelain dishes; one sample shall be covered with distilled water, one with a 3N solution of sulfuric acid and the other with a 50 percent solution of sodium



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sulfide. After one hour of immersion, the glass beads of each sample shall be examined microscopically for evidence of darkening and frosting.

### **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 or directed by the Engineer.

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. Newly placed surfaces need not be cleaned unless, in the opinion of the Engineer, the surface has become contaminated to the extent that cleaning is necessary to provide proper bonding. 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. At the time of application, the road surface temperature shall not be less than 60 degrees F and the pavement surface shall be absolutely dry. For 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. Despite the required minimum surface temperature and surface condition, the Engineer, at any time, may require that work cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse affect upon the working conditions.

The contractor shall use butt splices only and shall not overlap the marking material. All markings shall be thoroughly tamped with approved mechanical tampers.

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 marking tape shall be ready for traffic immediately after application.

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.

The application of preformed pavement markings shall be in accordance with the recommendations of the manufacturer of the material and these specifications; however, minor changes will be allowed if such are shown to produce an equal or better application and is approved by the Engineer. Failure to satisfactorily adhere to the pavement or to be satisfactorily removable shall be reason for disallowing the use of any particular type of marking material. Approval for use of any type of marking material is subject to satisfactory performance under traffic. Any failure during the time frame the material is scheduled to perform shall be repaired immediately by the contractor. Continued failure of a material to perform shall be cause for disallowing further use of that particular manufacturer's material.

Failure of materials, inadequate marking characteristics, or any other confusing or unsafe condition in a construction work zone will not be tolerated. Any condition where the safety of workmen or the traveling public might be endangered shall be remedied immediately by the contractor if so ordered by the Engineer.

#### **705-4 Method of Measurement:**

Measurement of preformed pavement marking arrows and legends will be made for each arrow or legend, as shown on the plans, furnished and applied in accordance with the requirements specified herein and on the plans.

Measurement of preformed pavement marking lines will be made by the linear foot along the center line of the pavement line and will be based on a four-inch wide stripe. Measurement for pavement lines with a plan width greater or less than the basic four inches will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

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.

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### **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, removal of Type II temporary markings, and maintaining Types II and III temporary markings in construction work zones.

When Type II or III temporary preformed pavement markings are required for maintaining traffic through a construction work zone, but are not listed as pay items in the bidding schedule, they will be considered as included in the lump sum paid for Maintenance and Protection of Traffic in accordance with Subsection 701-5.

Additional payment 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 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 will be paid for in accordance with the provisions of Subsection 109.04.

## **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 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 Reflective Pavement Markers:**

Reflective pavement markers shall be of the following type:

Type C	Clear, red
Type D	Yellow, two-way
Type E	Clear, yellow
Type G	Clear, one-way
Type H	Yellow, one-way

Reflective pavement markers shall be of the prismatic reflector type consisting of a molded methyl methacrylate or suitably compounded acrylonitrile butadiene styrene (ABS) shell filled with a mixture of an inert thermosetting compound and filler material. The exterior surface of the shell shall be smooth and shall contain one or two prismatic reflector faces of the color specified.

When illuminated by an automobile headlight, the color of the reflectors shall be an approved clear, yellow, or red as designated. Reflectors not meeting the required color may be rejected.

Permanent reflective pavement markers will be tested for compressive strength, abrasion resistance and specific intensity. Permanent reflective pavement markers shall have thin untempered glass or other abrasion resistant material bonded to the prismatic reflector face to provide an extremely hard and durable, abrasive resistant reflector surface.

The glass, or other abrasion resistant surface, is not required on the red faces of two-way (Clear/Red) permanent reflective markers. The area covered by the glass, or other abrasion resistant surface, shall not be less than three square inches.

Temporary reflective pavement markers will be tested for compressive strength and specific intensity. Temporary reflective pavement markers, or permanent reflective pavement markers used as temporary, will not be tested for abrasion resistance.

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The strength by compressive loading shall be at least 2,000 pounds for both permanent and temporary reflective pavement markers.

The original specific intensity of each reflecting surface for both temporary and permanent reflective markers shall not be less than the following:

<b>Reflectance:</b>	<b>Specific Intensity: candelas/foot-candle</b>		
<b>degrees incidence</b>	<b>Clear</b>	<b>Yellow</b>	<b>Red</b>
0	3.0	1.8	0.75
20	1.2	0.72	0.30

Permanent reflective pavement markers shall be subject to an abrasion resistance test as follows:

Steel Wool Abrasion Procedure: Form a one-inch diameter flat pad using No. 3 coarse steel wool per Federal Specification FF-W1825. Place the steel wool pad on the reflector lens face. Apply a force of 50 pounds and rub the entire lens surface 100 times. After the lens surface has been abraded, the specific intensity of each clear and yellow reflective surface shall be not less than that required above for the original specific intensity.

**706-2.03      Non-Reflective Pavement Markers and Reflectorized Dagmars:**

Non-reflective pavement markers shall be of the following types:

<b>Type</b>	<b>Color</b>
A	white
AY	yellow

Reflectorized Dagmars shall be of the following types:

- Type J      white
- Type JY    yellow

Non-reflective pavement markers and reflectorized dagmars 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 six 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 dagmars shall meet the following requirements:

Glaze Thickness: Inches	0.005 Minimum
Moh Hardness:	6 Minimum
Directional Reflectance: (White Only)	
Glazed Surface	75 Minimum
Body of Marker	70 Minimum
Yellowness Index: (White Only)	
Glazed Surface	0.07 Maximum
Body of Marker	0.12 Maximum
Color (Yellow Only):	
Purity: percent, range	75 - 96
Dominant Wave Length: $\mu$ , range	579 - 585
Total Luminous Reflectance (Y valve)	0.41 Minimum
Compressive Strength: pounds	1,500 Minimum
Water Absorption: percent	2.0 Maximum
Autoclave	Glaze shall not spall, craze or peel

Reflectorized dagmars 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.

**(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 C 424 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 C 773:

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 manufactured by an approved manufacturer. A list of approved manufacturers of bituminous adhesive 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 PRIDE 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:**

Pavement markers will be measured as a unit for each marker furnished and placed.

**706-5 Basis of Payment:**

The accepted quantities of 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 two 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



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"Standard Method of Test for Tensile Properties of Plastic," ASTM D 638 (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  $140 \pm$  three 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  $180 \pm$  three degrees F.

The post shall be conditioned a minimum of two hours at  $-5 \pm$  three 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  $4,000 \pm 1,000$  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. 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 four 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.

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 PERMANENT 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, lead-free, 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.

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Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted for each lot or batch of paint prior to its use.

**(B) Composition Requirements:**

The pavement marking paint shall be a ready-mixed, one component, water-borne lead-free 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 water-borne 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. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, toluene, chlorinated solvents, hydrolyzable chlorine derivatives, ethylene-based glycol ethers and their acetates, and not any carcinogen, as defined in 29 CFR 1910.1200. Lead content shall not exceed 0.06 percent of weight of the dry film, and the test for chromium content shall be negative.

No glass beads will be allowed in the pavement marking paint. Glass beads will be applied after the paint has been applied.

**(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 must be approved by the Engineer.

**(D) Quantitative Requirements of Mixed Paints:**

	White	Yellow
Pigment:		
Percent by weight, ASTM D 3723, allowable variation from qualifying sample	± 2.0	± 2.0
Non-Volatile Content:		
Percent by weight, ASTM D 2369, allowable variation from qualifying sample	± 2.0	± 2.0
Viscosity: Krebs Units at 77 ± 1 °F, ASTM D 562	70 - 85	70 - 85
Weight per Gallon:		
pounds per gallon 77 ± 1 °F, ASTM D 1475P, allowable variation from qualifying sample	± 0.3	± 0.3

Vehicle Composition:

	<b>White</b> None	<b>Yellow</b> None
Vehicle Infrared Spectra, ASTM D 2621, allowable variation from qualifying sample		
PH: ASTM E 70, allowable variation from qualifying sample	± 1.0	± 1.0
Fineness of Dispersion: HEGMAN, minimum, ASTM D 1210	3.0	3.0
Volatile Organic Compounds: pounds per gallon of paint, maximum, ASTM D 3960 according to 7.1.2.	2.1	2.1
Flash Point: Degrees F., minimum, ASTM D 93, Method A	100	100
Dry Time to No Pick Up: with no beads: minutes, maximum, ASTM D 711	10	10
Dry Through Time: Minutes, ASTM D 1640 except no thumb pressure is used when thumb is rotated 90° on paint film	20	20
Flexibility: TT-P-1952D	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. The color shall be checked visually, and will be checked against Tristimulus Values for the color according to Federal Test Method Standard No. 141.

**(2) Dry Opacity:**

Dry opacity for the paint will be determined using a black-white Leneta Chart, Form 2C Opacity and a Photovolt 577 Reflectance Meter or equal. Using a 10-mil gap doctor blade, a film of paint is drawn down, covering both black and white portions of the chart. The film shall be allowed to dry 24 hours. After calibrating the Reflectance Meter according to the manufacturer's instructions, measure the reflectance over the white and black portions with the green Tristimulus filter. Dry Opacity is calculated as follows:

$$\text{Dry Opacity} = \frac{\text{Reflectance over black}}{\text{Reflectance over white}}$$

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Dry Opacity for both white and yellow paint shall be a minimum 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. After 24 hours for drying, measure the reflectance of the paint film, using the green, blue, and amber Tristimulus filters. Calculate the Yellowness Index as follows:

$$\text{Yellowness Index} = \frac{\text{Amber} - \text{Blue}}{\text{Green}} \times 100$$

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 green Tristimulus filter. Reflectance for the white paint shall be a minimum of 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 G 53, for 300 hours total. The repeating cycle shall be four hours UV exposure at 60 °C followed by four hours condensate exposure at 40 °C. After 300 hours of exposure, the Yellowness Index for white paint shall not exceed 12, and yellow paint must still match Federal Standard 595b, Color No. 33538.

### **(6) Static Heat Stability:**

To determine static heat stability for the paint, place one pint of paint in a sealed can and heat in an air circulation oven at 120 ± one degrees F for a period of one week. Remove the paint from the oven and check the viscosity in Krebs Units at 77 ± one degrees F according to ASTM D 562. The viscosity measured must be in the range from 68 to 90, inclusive. Also, check for any signs of instability.

### **(7) Heat-Shear Stability:**

To determine heat-shear stability for the paint, one pint of the paint is sheared in a Waring Blender at high speed to 150 degrees F. The blender should have a tight fitting lid taped onto it to minimize volatile loss. When the paint reaches 150 degrees F, 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  $77 \pm$  one degrees F according to ASTM D 562. The viscosity measured must be in the range from 68 to 95 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 must be in the range from 68 to 95 inclusive.

#### **(8) Scrub Resistance:**

Scrub Resistance will be determined according to ASTM D 2486. Use an appropriate doctor blade to provide a dry film thickness of three to four mils. Allow the paint to cure for 24 hours. Perform the scrub resistance test at  $77 \pm$  one degrees F and  $50 \pm$  five percent humidity. Record the number of cycles to remove the paint film. The number of cycles recorded must be a minimum of 800.

#### **(9) Spraying Properties:**

The paint shall be applied at a 15 mils wet film thickness in the field. The paint shall show the following properties at ambient temperatures of 50 to 100 degrees F with a paint spray temperature of 150 degrees F, maximum, and six to eight pounds of post-applied glass beads per gallon of paint. Beads shall conform to subsection 708-2.02 of these specifications.

- (a) 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.
- (b) Produce a clean-cut, smooth line with no overspray or puddling.
- (c) 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.
- (d) 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 D 2243.

#### **(11) Road Service Rating:**

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Test stripes of the paint shall be applied transversely across the road, four 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 as determined according to ASTM D 4414 and ASTM D 713 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 these specifications (moisture proof type) will 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 a minimum of six pounds of beads per gallon of wet paint. The initial bead retention will be determined analytically by the ADOT 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 D 913.

After 180 days of service, on a visual rating scale of 0 to 100 percent, paints must have a rating of 92 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 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 advise the Engineer when paint is to be manufactured, 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 shall normally 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 a minimum of 14 working days prior to any traffic painting operation and to allow access at that time for paint sampling at the storage location.

A minimum of 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) Testing:**



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All tests will be conducted in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141, and methods in use by the Materials Group, Highways Division, and the Arizona Department of Transportation as specified herein.

Evidence of adulteration or improper formulation shall be cause for rejection.

### **(3) Packaging:**

All shipping containers for paint must comply with the Department of Transportation Code of Federal Regulations, Hazardous Materials and Regulation Board, Reference 49 CFR. The container and lids must 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 must 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.

### **(4) Marking:**

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 marked or labeled Rapid or Fast Dry lead-free Water-Borne 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.

### **(5) Unused Paint:**

Disposal of unused quantities of traffic paint shall be the responsibility of the contractor and must meet all applicable Federal regulations for waste disposal. Paint which is saved to be used later shall be

packaged as specified previously and shipped to a storage location. Unused paint must 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 shall be submitted.

### **(B) Physical Requirements:**

#### **(1) Gradation:**

When tested by the method provided in ASTM D 1214, the grade sizes of the beads shall be as follows:

<b>Size of Sieve</b>	<b>Percent Passing</b>
No. 30	100
No. 50	15 - 35
No. 70	0 - 15
No. 100	0 - 5

#### **(2) Roundness:**

When tested by the method provided in ASTM D 1155 (Procedure B), beads retained on any screen specified in the gradation requirements shall contain a minimum of 75 percent true spheres.

#### **(3) Index of Refraction:**

When tested by a liquid immersion method at a temperature of 25 °C, the beads shall have an index of refraction of 1.50 to 1.57.

**(4) Specific Gravity:**

The specific gravity of the beads shall be in the range 2.40-2.60 when tested in accordance with the following procedures:

Place 100 grams in an oven at 110 °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, 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.

**(C) Moisture Proofing:**

All glass beads shall have a moisture-proof overlay consisting of 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 pass the test for water repellency and free flow using the following equipment:

**(1) Test bag:**

The bag used is approximately 10-1/2 by 17-1/2 inches after sewing. The material used in the construction of the bag is unbleached cotton sheeting with a thread count of 48 by 48. The material before sewing is approximately 18 by 22 inches. The cloth is folded in half lengthwise and stitched in the shape of an "L" with the short side left open at the

top. The material can be obtained from selected manufacturers of cloth and paper packaging. The finished bag may also be obtained from the manufacturer of the glass beads.

Newly fabricated bags must be thoroughly washed with hot water and detergent and rinsed before use to remove the sizing which may be present in the cloth. Subsequent to the initial washing, the bags need only be rinsed clean of beads from previous tests and dried thoroughly before use.

**(2) Funnel:**

The funnel used is a standard laboratory funnel with a top opening diameter of 125 millimeters and a 150-millimeter stem length. The inside diameter of the stem is between nine and 10 millimeters. This funnel is available from most laboratory glassware supply houses, Corning No. 6100 or equal.

**(3) Ring Stand and Clamp.**

**(4) Balance accurate to 0.1 grams.**

**(5) Distilled water.**

**MOISTURE TESTING PROCEDURE:**

Glass beads shall be tested for compliance with specification requirements. Testing shall be conducted at standard conditions of temperature ( $25 \pm$  one degrees Celsius) and humidity ( $50 \pm$  five percent Relative Humidity) and shall consist of the following procedure or an approved alternate:

Weigh 900.0 grams of glass beads into a clean, dry, flat-bottomed pan.

Dry beads at  $150^{\circ}\text{C}$  for two hours.

Cool beads to room temperature ( $25 \pm$  one degrees Celsius) in a desiccator.

Using the clean, pre-washed bag described under apparatus section, turn the bag inside-out so that the sewn seam and seam-allowance are on the outside.

Quantitatively transfer the beads into the inverted cotton bag.

Grasp the gathered top of the bag with one hand and lower the bag into a container of distilled water until the beads are approximately one inch below the water level. The container shall be of such dimensions that the bag does not contact the bottom or sides during immersion. Each bag shall be immersed

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individually. Do not allow one bag to contact another if multiple tests are run.

Remove the bag after 30 seconds of immersion time.

Cradle the bottom of the bag uniformly in the palm of one hand and twist the top neck of the bag until the twisted bag is compressed firmly against the beads. Twist until excess water no longer drips from the bag.

After the excess water has been squeezed from the bag, allow the bag to unwind.

Gather the top of the bag and clamp. Suspend the bag on a ring stand or other support such that the bottom or sides of bag do not contact the support.

After a standing time of two hours at room temperature ( $25 \pm$  one degrees Celsius), remove bag from support. Mix sample thoroughly by holding the bottom seam allowance in one hand and gathered neck of the bag in the other, invert bag and shake up and down five times. Transfer the sample into a clean, dry funnel of the type described under apparatus. If consecutive tests are run, be sure the funnel is clean, dry and free of beads from prior tests.

The entire sample shall flow through the funnel without stoppage.

At the start of the test only, it is permissible to lightly tap the stem of the funnel to initiate flow.

Small quantities of beads which have adhered to the side of the funnel or stem shall not be cause for failure.

### **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:

The machine shall be capable of applying clear-cut lines of the width specified on the project plans.

The machines shall be equipped with a mechanical device capable of placing a broken reflectorized line with a 10-foot painted segment and a 30-foot gap.

The machine shall be 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 when using water-borne paint, nor when it can be anticipated that the atmospheric temperature will drop below said 50 degrees F temperature during the drying period. Water-borne paints shall not be applied if rain is expected within one hour of its application, unless otherwise approved by the Engineer. Water-borne paint shall not be heated to a temperature greater than 150 degrees F to accelerate drying.

The volume of paint in place shall be determined by measuring the paint tank with a calibrated rod. At the option 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.

### **Tolerances for Placing Paint, Beads, and Primer:**

The length of painted segment and gap shall not vary more than six inches in a 40-foot cycle.

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The finished line shall be smooth, aesthetically acceptable and free from undue waviness.

Painted lines shall be four, eight, or 12 inches wide as shown on the plans with a tolerance of  $\pm 1/8$  inch and shall be placed at a minimum rate of 16 gallons per mile for a solid four-inch line and four gallons per mile for a broken four-inch line, based on a 10-foot stripe and a 30-foot gap (40-foot cycle aggregate).

Glass reflectorizing beads shall be applied on the wet paint at a minimum rate of six pounds per gallon of paint.

Wet thickness shall not be less than 15 mils.

**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 four-inch wide stripe. Measurement for striping with a plan width greater or less than the basic four 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, 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, 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 PRIDE 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:

<b>Component</b>	<b>Percent by Weight</b>	
	<b>White</b>	<b>Yellow</b>
White Pigment (Titanium Dioxide)	18 min.	---
Yellow Pigment	---	23 - 30
Epoxy Resin	75 - 82	70 - 77

#### **(B) Epoxide Number:**

The epoxide number of the epoxy shall be determined in accordance with ASTM D 1652 for both white and yellow resin material on a pigment free basis. The epoxide number shall be within  $\pm 50$  of the published manufacturer's standard for the approved product.



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### **(C) Amine Number:**

The amine number of the curing agent shall be determined in accordance with ASTM D 2074. The amine number shall be within  $\pm 50$  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 ( $75 \pm 2$  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 D 2240, shall have a Shore D Hardness of between 70 to 95. The samples shall be allowed to cure at room temperature ( $75 \pm 2$  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 C 501, 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  $0.020 \pm 0.0005$  inches to code S-16 stainless steel plates. The samples shall be allowed to cure at room temperature ( $75 \pm 2$  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 D 638, 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 ( $75 \pm 2$  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 D 695, 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 ( $75 \pm 2$  degrees F) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated tests.

**(J) Retroreflectance:**

White and yellow dual component marking materials shall have the following minimum retroreflectance values at 86.5 degrees illumination angle and 1.5 degrees observation angle as measured by a Mirolux 12 portable retroreflectometer. The readings shall be taken from sample plates of markings applied in the field on the project to the specified thickness and bead application rate. The contractor and Engineer shall coordinate on procedures for sampling and handling of samples.

<b>Product</b>	<b>Retroreflectance (Millicandelas)</b>
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 conform to the following requirements:

The white color shall match Federal Test Standard Number 595B, color chip no. 37875.

The yellow color shall match Federal Test Standard Number 595B, color chip no. 33583.

**(L) Yellowness Index:**

The white material shall not exceed a yellowness index of 23 when tested in accordance with ASTM D 1925. The index shall be based on a sample which has been cured for 72 hours at room temperature ( $75 \pm 2$  degrees F) and exposed in the QUV chamber for 72 hours.

**(M) Viscosity:**

The formulations of each component part shall be such that the viscosity of both parts, when measured in accordance with ASTM D

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2196, 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 D 711, 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 ( $75 \pm 2$  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 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 D 1155, 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 D 1214:

<b>TYPE A GLASS BEADS (Large Bead)</b>	
Sieve No.	% Retained
10	0
12	0 - 5
14	5 - 25
16	40 - 80
18	10 - 40
20	0 - 5
Pan	0 - 2

<b>TYPE B GLASS BEADS (Small Bead)</b>	
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).

Certificates of Analysis conforming to the requirements of Subsection 106.05 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

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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 three to four 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 one 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):

Nature, type, color and formulation of the material;  
Manufacturer, batch number and date of manufacture;  
Application requirements and constraints; and  
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 one inch beyond the width of the marking to be installed.

**(E) Pavement Temperature and Condition:**

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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 four 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 three to four 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 D 1212, 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 D 1212. 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.



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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 709-3.02(F)(1).

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). 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 D 1212. 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  $0.025 \pm 0.002$  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  $0.020 \pm 0.002$  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  $0.020 \pm 0.002$  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:**

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The thickness of dual component pavement markings for transverse lines, symbols, and legends shall be  $0.025 \pm 0.002$  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  $0.025 \pm 0.002$  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) 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 one inch in 100 feet. The longitudinal deviation of a marking line and gap shall not vary more than six 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	$\pm 1$ 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).

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  $\pm$  five 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.

**709-4 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 four-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 four inches, as shown on the plans or directed by the Engineer, will be made by the following method:

$$\frac{\text{Plan Width of Striping, (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

Double marking lines, consisting of two four-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 four 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,"

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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 shall be measured by the linear foot for striping lines regardless of width, or unit each for symbols and legends, in accordance with the items of work established in the bid schedule.

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 710-729 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.

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### **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.



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The contractor shall submit six copies of a complete project material submittal for approval at the pre-construction conference which shall conform to these specifications. 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.

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 six copies of photometric data sheets indicating the IES distribution classification for each type of luminaire submitted for approval. 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.

**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, 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.

**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 project plans and in accordance with the details shown on the plans and the requirements of these specifications.

Pole foundations shall include all conduit, elbows, anchor bolts, grounding wire and reinforcing steel. Cabinet foundations shall include conduit, elbows, anchor bolts and clearance pad.

**731-2 Materials:**

Excavation and backfill shall conform to the requirements of Subsection 203-5.03. Concrete shall conform to the requirements of 1006 and 601. Reinforcing steel and wire mesh shall conform to the requirements of 1003 and 605.

Concrete for all foundations shall be Class S and shall have a required 28-day compressive strength of 3,000 pounds per square inch.

**731-2.01 Blank****731-2.02 Standard Steel Poles:****(A) General:**

Standard steel poles for traffic signals and highway lighting shall include pole shafts and pole bases.

Material standards for traffic signal and lighting supports shall be in conformance with the current edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. All pole supports shall be designed to withstand 70-mile per hour winds except for the type K and R poles. The type K & R poles shall be designed to withstand 80-mile per hour winds. 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 Subsection 604-3.06.

**(B) Pole Shafts:**

Tapered pole shafts shall be fabricated from sheet steel of weldable grade which shall meet or exceed the minimum strength requirements of ASTM A 36, for all poles except the type K and R poles. The type K and R poles shall be constructed from sheet steel that has a minimum yield stress, after fabrication, of 48,000 pounds per square inch. A taper rate of 0.14 inches in diameter per linear foot shall be required unless otherwise specified. Pole shafts shall be fabricated according to the thickness requirements shown on the plans.

Standard pipe pole shafts shall be fabricated from standard weight structural steel which conforms to the minimum strength requirements of ASTM A 53, Grade B, and a nominal diameter indicated on the Standard Drawings. 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 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 A 123. 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.

**(C) 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 A 53. All welding shall conform to the requirements of Subsection 604-3.06. Pole extensions and twin luminaire brackets shall be fully galvanized in accordance with the requirements of ASTM A 123. Fabrication of the pole extensions and twin luminaire brackets shall be in accordance with the dimensions as specified in the plans.

**(D) Standard Bases:**

Poles shall have standard bases unless break-away or slip-away bases are specified. Standard bases shall be fabricated from structural steel plates conforming to the minimum strength requirements of ASTM A 36. 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 A 123.

**(E) Slip-Away Bases:**

Slip-away bases shall be fabricated from structural steel conforming to the requirements of ASTM A 36. Exposed surfaces shall be finished smooth and all exposed edges shall be neatly rounded to a 1/8-inch radius. Slip-away bases shall be galvanized in accordance with the requirements of ASTM A 123 and shall have all the necessary hardware to make a complete and functioning unit. High strength flat washers, bolts and nuts used to connect slip-away base plates shall conform to the requirements of ASTM A 325 and shall be electro-galvanized in accordance with the requirements of ASTM B 633. Slip-away bases shall be used on roadway lighting poles where specified on the plans.

**(F) Break-Away Bases:**

Break-away bases shall be fabricated from 365 T4 or SG 70AT6 aluminum alloy. The base shall be heat-treated in accordance with the requirements of ASTM B 108, temper designation T6, before shipment. The break-away base shall have all the necessary hardware to make a complete and functional unit. Bolts, washers and nuts shall meet or exceed ASTM A 36 minimum strength requirements and shall be fully galvanized in accordance with ASTM A 153.

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 and that the castings have the same chemistry, mechanical properties, and geometry as the castings used in the tests.

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Break-away bases shall be used where specified on the project plans.

### **(G) Anchor Bolts:**

All anchor bolts shall be threaded at the top and shall conform to the plans.

Standard anchor bolts, washers, and nuts shall be fabricated from steel conforming to the strength requirements of ASTM A 36. The anchor bolts, washers, and nuts shall be fully galvanized in accordance with the requirements of ASTM A 153.

High strength anchor bolts, washers and nuts shall be fabricated from steel which meets or exceeds the minimum requirements of ASTM A 325 and shall be electro-galvanized in accordance with the requirements of ASTM B 633. Welding shall not be performed on any portion of the body of these anchor bolts. Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted for high strength anchor bolts, washers and nuts.

## **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 AWWPA 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:**

#### **(1) AWWPA:**

American Wood Preservers Association.

#### **(2) Supplier:**

The person, partnership, association, or corporation furnishing the material covered by these specifications.

#### **(3) 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.

**(4) Compression Wood:**

Abnormal wood that often forms on the lower side of branches and inclined trunks of coniferous trees. Characteristics include:

- (a) relatively wide annual ring, usually eccentric;
- (b) relatively high proportion of summerwood (frequently more than 50 percent of the width of the annual ring in which it occurs);
- (c) exhibits very little contrast in color between springwood and summerwood; and
- (d) shrinks excessively lengthwise as compared with normal wood.

**(5) 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.

**(6) 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 one to two 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.

**(7) 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.

**(8) Decay:**

Decay or rot (advanced decay) is the disintegration of wood substance due to the action of wood destroying fungi.

**(9) Face of Pole:**

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The concave side, or the side of greatest curvature in poles having reverse or double sweep, between the ground line and top of pole.

### **(10) Ground Line Section:**

That portion of a pole between one foot above and two feet below the ground line as defined in the pole dimension tables.

### **(11) Hollow Heart:**

A hollow in the heartwood of a living tree caused by insects or fungi.

### **(12) 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).

### **(13) 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.

### **(14) 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.

### **(15) 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.

### **(16) 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) for blue stain.

### **(17) 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.

### **(18) Shake:**

A separation along the grain, the greater part of which occurs between the rings of annual growth.

**(19) Short Crook:**

Any localized deviation from straightness, in a five-foot section or less, shall be classified as a short crook.

**(20) 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).

**(21) Split:**

A lengthwise separation of the wood due to the tearing apart of the wood cells, extending from surface to surface of the pole.

**(22) 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  | ( <i>Pinus taeda</i> )           |
| (b) Longleaf  | ( <i>Pinus palustris</i> )       |
| (c) Pond      | ( <i>Pinus rigida serotina</i> ) |
| (d) Shortleaf | ( <i>Pinus echinata</i> )        |
| (e) Slash     | ( <i>Pinus caribaea</i> )        |
| (f) Ponderosa | ( <i>Pinus ponderosa laws</i> )  |

**(D) Defects:****(1) Prohibited Defects:**

Pole exhibiting any of the following defects will not be accepted:



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- 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
- 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 two 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 one-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.

<b>Length/Class of Pole</b>	<b>Diameter of Any Single Knot</b>	<b>Sum of Diameters of Knots in Any One-Foot Section</b>
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 two 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 One-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

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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 three 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 two inches from the outside diameter of butt.

### **(l) Short Crook:**

Any localized deviation from straightness in a five-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 six 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 one 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 six 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 three inches shorter or six inches longer than nominal length.

Poles 50 feet or more in length shall be not more than six 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 six 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 six 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:

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The following marks shall be burn-branded legibly on the butt and on the face of the pole per AWP Standard M6 at a point 12 feet  $\pm$  two inches tolerance:

The supplier's code or trademark.

The Plant location and the year of treatment.

Code letters denoting pole species and preservative used.

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 AWP Standard P8. The carriers shall be hydrocarbon solvents Type B or D conforming to AWP Standard P9.

## **(H) Treatment:**

### **(1) Poles:**

Poles shall be treated in accordance to AWP 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 two inches in fir or 2-1/2 inches in pine.

### **(3) Retention:**

Douglas Fir - The treating process must produce not less than one inch penetration at any point on the pole. If the sapwood thickness exceeds

one inch between the butt and standard ground line, 85 percent of the sapwood shall be treated. The assay zone shall be 1/4 to one 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 Wetzal 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 AWPAs 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 AWPAs Standard C1.

Cut Back Poles - All poles that are shortened or trimmed shall be retreated within seven days conforming to AWPAs Standard C1.

#### **(I) 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.

#### **731-2.04 Mast Arms and Tie Rods:**

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Mast arms for standard steel poles that are not tapered shall be fabricated from steel pipe as specified in ASTM A 53. The arms shall conform to the dimensions shown on the Standard Drawings. The pipe shall be one piece and free from burrs.

Tapered mast arms shall be fabricated from sheet steel conforming to the requirements of ASTM A 36, except for the types K and R pole mast arms. The mast arms for the types K and R poles shall be constructed of sheet steel with a minimum yield stress of 48,000 pounds per square inch after fabrication. Mast arms shall be fabricated according to the thickness requirements shown on the plans. A taper rate of 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 fabricated from steel conforming to the requirements of ASTM A 325 and shall be electro-galvanized in accordance with the requirements of ASTM B 633.

Mast arms shall be bent to the dimensions and curvature shown on the plans.

Tie rods shall be fabricated from weldable structural steel pipe and steel rod and shall have no kinks or bends. All dimensions of the tie rods shall be as specified in the plans, except that the mast arms and tie rods for wood pole installations shall conform to the details shown on the project plans.

Mast arms and tie rods shall be galvanized in accordance with the requirements of ASTM A 123. 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 and tie rods 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 as required on the plans, mast arm or pole drawing number, length, and gage number.

### **731-3 Construction Requirements:**

#### **731-3.01 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. 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 project plans. The dimensions and locations of foundations shall be as specified on the project 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.

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 three days prior to pole installation except for types J, K, Q and R pole foundations which shall set for seven days.



Before the concrete for cabinet foundations has set, depressions shall be made around the anchor bolts for adjustment of the cabinet leveling nuts.

### **731-3.02 Base Plates and Poles:**

High strength bolts, nuts, and washers for slip-away bases shall be assembled as specified in the Standard Drawings and shall be torqued as required by the Standard Drawings. 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 six 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 six 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.

New poles that are damaged by improper drilling of holes will be rejected.

### **731-3.03            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 B 3 for annealed bare copper wire. Conductors for sizes number 8 AWG and larger shall be stranded and shall conform to ASTM B 8 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 or 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						
CIRCUIT	SIGNAL PHASE OR FUNCTION	INSULATION		CONDUCTOR		
		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	Red	THW	45	12	
	Hand/Man	Green	THW	45	12	
Pedestrian Push- Button	Pedestrian Detection	Orange	THW	45	12	
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 °C and have a moisture absorption of less than one 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 °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 °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
* 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 °C to +80 °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 °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.

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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 four-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 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 one 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 F 656 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 D 2564. 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 six inches.

If a trench has to be left open overnight, a minimum of six 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



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material, suitable running boards, suitable sleeves, or other approved means.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5.

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 three 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 two feet of pull wire doubled back into the conduit and capped.

A three-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 six to eight inches below the finished grade.

Conduit entering pull boxes shall terminate a minimum of three inches inside the box wall. The conduit shall be between two and four 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 two 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, 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.

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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 one 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 five 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 six foot by six 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 nine 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.

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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 three 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, 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, and acceptable to the Engineer, shall be applied to the plywood before the components are

mounted. Special care shall be taken to insure 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:

- (1) From center to center of pull boxes.
- (2) From edge of foundation to center of pull box.
- (3) From edge to edge of foundation.
- (4) From end of conduit to center of pull box.
- (5) 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.

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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:

- (1) From center to center of pull boxes.
- (2) From edge of foundation to center of pull box.
- (3) From edge to edge of foundation.
- (4) From end of conduit to center of pull box or foundation.
- (5) 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 eight-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 °C.

**(3) Visors:**

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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 five inch backplates installed. All eight inch signal faces shall have eight inch backplates installed.

### **(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), 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 two 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).

## **(C) Fiber Optic Turn Arrow Signal:**

### **(1) General:**

Each fiber optic signal unit shall conform to the provisions in Subsection 733-2.01(A) 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

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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.

### **(3) 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.

### **(4) 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.

### **(5) 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 nine 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 nine 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.

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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 seven 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 one-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).

**(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).

**(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:**



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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). 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 eight-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 four-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

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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 Suppressor
- Cabinet Ventilation Fan
- Terminal Tie Points

## 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:

- Table of Contents;
- Operating Procedure;
- Theory of Operation;
- Step by step maintenance and trouble-shooting information for the entire assembly and for all components capable of being adjusted;
- Circuit Wiring Diagrams;
- Pictorial Diagrams of Parts Locations; and
- 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 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.

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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 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.

### **(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.
- (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:**

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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 two 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.
- (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 five 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.



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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:**

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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:

- 1) Start-up programs:**
- 2) Each signal plan and sequence programs:**
- 3) Back-up times:**
- 4) Remote flash operation programs:**
- 5) Cycle back-up times:**
- 6) Offset back-up times:**

**7) Pre-emption plan and sequence programs:**

**8) 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.

**9) 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.

**10) 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	<u>f</u>	Det. 1
B	24-Volt DC	<u>g</u>	Det. 5
C	Voltage Monitor	<u>h</u>	Det. 9
D	Sig. Ckt. # 3	<u>i</u>	-
E	Sig. Ckt. # 6	<u>j</u>	Remote Flash
F	Sig. Ckt. # 10	<u>k</u>	Guar. Interval
G	Sig. Ckt. # 13	<u>m</u>	-
H	Sig. Ckt. # 12	<u>n</u>	Signal Plan 2 (Preempt 1)
J	Sig. Ckt. # 11	<u>p</u>	AC +
K	Det. 2	<u>q</u>	Master Sync (Out)
L	Det. 6	<u>r</u>	Spare
M	Det. 10	<u>s</u>	Sig. Ckt. # 1
N	Stop Time	<u>t</u>	Sig. Ckt. # 4
P	Coord. Sync (IN)	<u>u</u>	-
R	External Start	<u>v</u>	-
S	Manual (Interval Advance)	<u>w</u>	Overlap Advance
T	Indicator Lamp Control	<u>x</u>	Free
U	AC -	<u>y</u>	Cycle 2
V	Chassis Gnd	<u>z</u>	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
<u>a</u>	Sig. Ckt. # 5	EE	-
<u>b</u>	Sig. Ckt. # 9	FF	Signal Plan
<u>c</u>	Sig. Ckt. # 8	GG	Split 2
<u>d</u>	-	HH	Cycle 3
<u>e</u>	Sig. Ckt. # 14		

CONNECTOR B			
Pin No.	Function	Pin No.	Function
A	Free Output	<u>f</u>	Spare
B	Flash Cont.	<u>g</u>	Spare
C	Spare	<u>h</u>	Det. 12
D	Sig. Ckt. # 15	<u>i</u>	Det. 11
E	Sig. Ckt. # 16	<u>j</u>	Cycle 4 (Optional Function)
F	Sig. Ckt. # 17	<u>k</u>	-
G	Sig. Ckt. # 24	<u>m</u>	-
H	Sig. Ckt. # 26	<u>n</u>	-
J	Sig. Ckt. # 27	<u>p</u>	Sig. Ckt. # 30
K	-	<u>q</u>	Sig. Ckt. # 31
L	Det. 4	<u>r</u>	-
M	Det. 8	<u>s</u>	Sig. Ckt. # 21
N	Det. 3	<u>t</u>	Spare
P	Det. 7	<u>u</u>	Sig. Ckt. # 40
R	Offset 3	<u>v</u>	-
S	Offset 2	<u>w</u>	Sig. Ckt. # 38
T	-	<u>x</u>	-
U	Offset 1	<u>y</u>	-
V	CMU Stop Time	<u>z</u>	-
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
<u>a</u>	Sig. Ckt. # 20	EE	Sig. Ckt. # 39
<u>b</u>	Sig. Ckt. # 22	FF	Sig. Ckt. # 32
<u>c</u>	Sig. Ckt. # 23	GG	Sig. Ckt. # 35
<u>d</u>	Sig. Ckt. # 25	HH	Sig. Ckt. # 33
<u>e</u>	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:

<b>Signal Output Circuits:</b>	
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.

### **11) 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.

### **12) 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.



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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:

- (1) Guaranteed yellow change interval: three seconds
- (2) 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:

<b>Any Vehicle and Pedestrian Phase Movement (Non-Actuated)</b>	
Interval	Time in Seconds
Minimum Green	25
Walk (Solid)	7
Ped Clearance (Flashing)	10
Yellow Change	4
Red Clearance	2

<b>Any Vehicle and Pedestrian Phase Movement (Actuated)</b>	
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.

<b>Any Vehicle Exclusive Turning Phase Movement</b>	
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:

- (1) 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.
- (2) All non-NEMA input/output functions shall be contained in a system or "D" connector only.
- (3) 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.
- (4) The "D" Connector shall be located on the front panel.
- (5) 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.

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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:

- (1) All non-NEMA functions and phases shall be contained in a "D" connector or auxiliary connector on the front panel.
- (2) The controller shall include twelve phases with both vehicle and pedestrian timing.
- (3) 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.
- (4) The controller shall contain two additional overlaps to the four NEMA overlaps.
- (5) The controller shall include Time Base Coordination and three pre-emption programs.
- (6) The controller shall accept up to sixteen 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:
  - (a) 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.
  - (b) 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.
  - (c) 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:

- (1) The cabinet shall be wired for call to non-actuated mode I for the highway and mode II for cross street, unless otherwise specified.
- (2) 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.
- (3) 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:**

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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.

### **1) 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.

### **2) 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 than 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.



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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.

### **3) 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
- (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

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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. 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.
- (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.
- (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:****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 four 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

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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  $\pm$  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 two 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.



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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 °C rated jacket, or No. 16 copper conductor with a 105 °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. 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

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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.

### **(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 five degrees of the zero voltage point of the line sinusoid and shall turn off within five 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:

<b>Terminal</b>	<b>Function</b>
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

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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. Jumpers 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:

<b>Standard Input and Output Functions for Vehicle Detection Assembly</b>			
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 six- by six-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 six by six-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: six by six feet - two-turn, six by 50 feet - one-turn, six by 70 feet - one-turn; up to six by 100 feet - one-turn loops. The smaller size six by six-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:

<b>Standard Input and Output Functions for Vehicle Detection Assembly</b>			
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	



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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 four positions:

1. Between B/2 and C/3
2. Between M/H and N/12
3. 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 three 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:

- (1) 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.
- (2) 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  $\pm 5.0$  percent from the quiescent turning point regardless of initial circuit drift.
- (3) 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.

- (1) 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.
- (2) 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 setting 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  $\pm 0.05$  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 three 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 five-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:

**1) Inhibit Pulse Timing:**

This timing function shall inhibit subsequent call outputs up to five seconds after each vehicle leaves the sensor area.

**2) 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 two 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 five 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 five 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:**

**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.
- (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

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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.
- (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 five 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)
- (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 nine inches wide by eight 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 four 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 vehicular 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 these 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 and passage of vehicles.

**(B) Loop Detectors:**

The detector loop dimensions shall be as specified on the plans.

The conductors for the inductive loop detector and the loop detector lead-in cable shall be as specified in Subsection 732-2.01(B)(1).

**(C) Magnetometer Detector:**

Each sensing probe shall consist of a sensitive flux gate magnetometer. The magnetometer shall operate properly when excited by a triangular current of plus or minus 75 milliamps peak at five kilohertz. For a single probe in a magnetic field of 400 millioersted, the return signal shall be at least 50 millivolts RMS at 10 kilohertz. The return signal shall reverse phase when the field passes through zero.

The sensing probes shall be cylindrical having maximum dimensions of 7/8-inch diameter by four inches long. The sensing probes shall be suitable for installation in a one-inch diameter bored hole. The interconnecting four-conductor cable shall be suitable for installation in a 1/4-inch wide pavement sawed slot.

The jacket on the interconnecting cable and the casing on the sensing probe shall be an abrasion resistant polyurethane elastomer. The device shall be impervious to moisture and chemically resistant to all normal motor vehicle petroleum products.

Probe set operation shall be unaffected by temperature change, water and ice. The probes shall be operational in power line AC magnetic fields ranging to 100 millioersted peak to peak. The probe set shall be operational from -30 to +160 degrees F.

The conductor cable from the magnetometer to the adjacent pull box shall be as specified by the detector manufacturer and shall be a minimum of 50 feet in length. Each magnetometer sensor shall have one lead-in cable.

The lead-in cable from the pull box, adjacent to the magnetometer, to the control cabinet shall be unspliced and the type specified in Subsection 732-2.01.

**(D) Encapsulated Loop Detector Probe:**

The encapsulated loop detector probe shall detect the passage or presence of all vehicles with a standard loop detector amplifier. The dimensions of the loop detector probe shall be 0.88 inches in diameter and 3.6 inches in length. The lead-in cable shall fit in a 1/4-inch saw cut.

The loop detector probe shall operate in a temperature range from -35 to +165 degrees F with zero to 100 percent relative humidity.

The operating field intensity range shall be 200 to 1,000 millioersted with a nominal inductance of 20 microhenries plus 20 microhenries per 100 feet of cable. The nominal DC resistance shall be 0.5 ohms plus 3.2 ohms per 100 feet of probe cable.

**735-2.02 Pedestrian Push-Button Detectors:**

The pedestrian detector shall be a push-button switch mounted inside an approved push-button housing. The switch shall be the phenolic-enclosed SPST-type with momentary contacts. The contacts shall be rated at 15 amps and 125 volts AC. The switch shall have screw-type terminals and shall have a rated life of not less than one million operations. The switch shall operate in the normally open position.

The housing of the push-button station shall be of substantial tamper-proof construction made of cast aluminum. The assembly shall be weather-proof and so constructed that it will be impossible to receive any electrical shock under any weather conditions. The housing shall be shaped to fit the curvature of the pole to which it is attached and shall provide a rigid installation. The housing body shall contain a direct push-type actuator button, microswitch-type or approved equal. The housing cover shall contain the push-button sign as described below or as specified in the Special Provisions.

Pedestrian push-button signs shall be made with porcelain enameled 20 gage sheet steel, 9.5 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.

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The legend shall be as shown on the plans or as specified in the Special Provisions.

735-2.03            **Isolated Relay Inputs:**

Each pedestrian push-button or remote vehicle detector call input from an auxiliary cabinet, shall be isolated from the controller logic ground as specified in Subsection 734-2.04.

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)            **Emulsified Crack Filler Sealant for Asphaltic Concrete:**

Emulsified crack filler sealant may be used to seal saw cuts in asphaltic concrete and lean concrete base. The emulsified crack filler sealant shall conform to the requirements of the following table:

<b>Emulsion (For Crack Filling)</b>		
<b>Tests on Emulsion</b>	<b>Test Method</b>	<b>Requirement</b>
Viscosity: Saybolt Furol, 25 °C, seconds, range	ASTM D 244	25-150
Retained on No. 20 sieve: percent, maximum	ASTM D 244 (1)	0.10
Particle Charge:	ASTM D 244	Positive
Pumping Stability:	(2)	Passes
Settlement: 5 days, percent, maximum	ASTM D 244	5.0
Residue: percent, minimum	ASTM D 244 (3)	60.0
<b>Test on Residue</b>		
Viscosity: 60°C, centistokes, range	ASTM D 2170	100 - 9500
(1)Distilled water will be used instead of the two percent sodium oleate solution.		
(2)450 mL of emulsion will be charged into a one-liter beaker and circulated through a gear pump (Roper 29 B 22621) having a 1/4-inch inlet and outlet. Pumping stability is acceptable if there is no significant oil separation after a circulation of 60 minutes.		
(3)ASTM D 244 is modified by heating a 50-gram sample to 149 oC until foaming ceases, then cooling it immediately.		

The emulsified crack sealant shall remain homogeneous within 30 days of delivery and shall be homogeneous after thorough mixing. The emulsified crack sealant shall be freeze-stabilized, and, if freezing has occurred, a homogeneous mixture shall be obtained when the material has thawed and been thoroughly mixed.

(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 with non-flammable solvents such as 1,1,1 trichloroethane or Scotch-Grip Brand Solvent No. 4 (prior to curing of encapsulant). 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.



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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 nontracking 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.

**(B) Hold Down Tabs:**

Hold down tabs shall be installed in the saw cut on top of the wire every two feet. The tabs shall be installed after the loop wire installation and prior to the sealant installation. The tabs shall be individual sections of PVC tubing one inch in length which shall be bent and wedged tightly into the saw cut channel.

**(C) Saw Cut Sealants:**

Saw cuts shall be sealed with an approved sealant. All slots cut in the pavement shall be blown out and dried before installing conductors. After the conductors are installed in the slots, the slots shall be filled to within 1/8 inch of the pavement surface with the sealant. Before the sealant sets up, the surplus sealant shall be removed from the road surface without the use of solvents. The handling of the sealant and the filling of the saw cut shall be in accordance with the directions of the manufacturer. Sand blotter shall be applied as directed by the Engineer.

**(D) Splices:**

The detector sensor conductors shall be spliced to the detector lead-in cable in the adjacent pull box. Detector lead-in cables shall run continuous and unspliced to the controller cabinet. Detector lead-in cables shall not be spliced without the approval of the Engineer.

All detector wire splices shall be soldered using resin-core solder with 60 percent tin and 40 percent lead. The splices shall be sealed from moisture with self encapsulating fit caps. When heated, the fit cap's inner thermoplastic adhesive shall temporarily melt and the fit cap's outer wall shall shrink. 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.

**(E) Detector Loop Installation Field Tests:**

Before and after the saw cut sealant has been installed, the contractor shall perform an insulation resistance-to-ground test. The insulation resistance-to-ground shall be at least 50 megohms when measured at a voltage between 400 and 600 volts D.C.

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Any loop detector that does not meet the above requirement or cannot be tuned to the Engineer's satisfaction shall be replaced by the contractor at no cost to the Department.

### **(F) Magnetometer Field Tests:**

If the probe locations shown on the project plans occur in the following areas, the contractor shall request the Department to perform a magnetic field analyzer test:

Within 24 inches of a metal object such as a manhole cover or large pipe.

Within 24 inches of railroad tracks.

Within tunnels, iron structures, or in bridge decks.

After the above analyzer test has been performed, the Contractor shall install the probes where directed by the Engineer.

### **735-3.02 Blank**

### **735-4 Method of Measurement:**

Loop detectors, magnetometer detectors and pedestrian detectors will be measured as a unit for each type of detector furnished and installed.

### **735-5 Basis of Payment:**

Loop detectors, magnetometer 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.

## **SECTION 736 HIGHWAY AND SIGN LIGHTING:**

### **736-1 Description:**

The work under this section shall consist of furnishing and installing or modifying highway lighting systems or sign illumination 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 conform to the requirements of this section and be of the type and size specified. All lighting fixtures shall be supplied complete with lamps.

**(A) Horizontally-Mounted High Pressure Sodium Luminaries:**

The luminaires shall be 150-, 250-, or 400-watt, as specified, high pressure sodium luminaires of the horizontal burning type. The housing, together with the reflector, shall be of sufficient size to properly utilize the high pressure sodium lamps designated. The light distribution shall be Type III medium cutoff unless otherwise specified and shall conform to the Illumination Engineering Society (IES) standards.

Each luminaire shall be furnished with an instruction sheet which clearly shows installation procedures and instructions for adjusting the lamp socket. This instruction sheet shall include complete information on all socket positions and the IES light distribution produced from each setting.

**(1) Luminaire Housing:**

The luminaire housing shall be fabricated from a noncorrosive material. The lower portion of the luminaire shall be composed of two parts. One part shall contain the 90-degree cut-off type flat glass optical assembly, and the other part shall be the ballast module door. The ballast module door shall contain all the major electrical components and shall be capable of being lowered after loosening a single stainless steel captive screw. The ballast shall be pre-wired to the lamp socket and terminal board. The ballast module door assembly shall be removable and replaceable by the use of quick disconnect plugs. The optical assembly holder shall have an automatic latch with a safety catch on the house side. The holder shall be forced upward at the street side by spring pressure against the gasket seal when in the closed and latched position. The luminaire shall have a slipfitter for mounting on a two-inch nominal mast arm tenon and shall be adjustable for leveling plus or minus three degrees from the horizontal. The optical assemblies and housing size for the 150- and 250-watt luminaires shall be the same size as is used for 400-watt luminaires.

**(2) Optical Assembly and Gaskets:**

The optical assembly shall incorporate a snap-on, high specular, anodized reflector and shall contain a filter which effectively absorbs gaseous contaminants or particulate matter.

The flat glass of the optical assembly shall be manufactured of high quality, heat resistant glass.

A gasket of an approved neoprene material that will maintain a watertight and dust-tight seal throughout the temperature ranges inherent with high intensity discharge lamps, shall be securely fastened to the reflector. The gasket between the lamp socket and the reflector shall be polyester fiber that will maintain a dust-tight seal throughout the above specified temperature ranges.

The lamp socket shall be of rugged, high grade porcelain securely mounted to a support bracket which is adjustable in both the vertical and the horizontal directions. Each adjustment shall be clearly and permanently coded for each light distribution setting. The coding shall directly relate to the instruction sheet furnished with each luminaire.

**(3) Ballast:**

The ballast shall be a three-winding lag-type magnetic regulator and shall be capable of starting lamps at 40 degrees F and operating the lamps within the limits specified by the lamp manufacturer. The starting amperes shall be less than operating amperes. The ballast shall provide the lamp voltage shown in the lamp table of Subsection 736-2.01(C). The ballast shall be prewired to the lamp socket and terminal board. Ballast shall be rated to the circuit voltage and size of the lamp specified. The ballast shall be capable of operating for a six month period during a short circuit failure, lamp open, or end of life cycle without any measurable deterioration to the ballast.

The ballast shall have the following characteristics:

	Initial (Percent)	End Of Lamp Life (Percent)
Power Factor	99	90
Lamp Regulation Spread	14	18
Input Voltage Dip Tolerance	60	30
Lamp Wattage Regulation	0.8 percent for each one percent of line voltage	
Line Voltage Variation	± 10	

**(B) Vertically-Mounted High Pressure Sodium  
Luminaires:**

The 250- or 400-watt vertical luminaires specified on the plans shall be a pole-top-type fixture and shall be mounted with a vertical slipfitter. The vertical luminaires shall be an approved pole-top fixture, designed to illuminate roadways from offsets of up to 50 feet.

The luminaire shall be an enclosed design with an optical system consisting of a single-piece hydroformed, specular, anodic finished, aluminum reflector and a prismatic borosilicate, thermal resistant glass refractor.

The lamp socket shall be permanently attached to the reflector to assure correct lamp positioning at all times, and shall be provided with a quick disconnect for easy removal of the reflector socket assembly.

**(1) Luminaire Housing:**

The housing of the luminaire shall be cast aluminum with a baked enamel finish and shall consist of a housing containing the reflector and electrical equipment, and a refractor housing which shall be securely attached to the main housing by means of two stainless steel top hinges and two trigger actuated bottom latches. The refractor housing shall be readily removable for luminaire servicing.

**(2) Gaskets:**

Seals and/or gaskets shall be provided at all critical points to prevent entry of contaminants. A breathing seal, polyester fiber gasket shall be provided at the lower juncture of the housings to filter air entering the fixture. Neoprene gasketing shall be used at all other junctures between the housings.

**(3) Adjusting and Aiming Device:**

The luminaire shall be equipped with a vertical slipfitter and a leveling and aiming adjustment assembly for rapid and versatile field installation and adjustment. The slipfitter assembly may be manufactured from cast steel or have a galvanized steel pipe and yoke assembly. The galvanized steel pipe and yoke assembly shall have a weather-tight wiring box with a No. 14 AWG, three-conductor, Type ST, 105 °C ballast cord. The slipfitter shall accept pole tenons from 2-3/8 inches to 3 inches outside diameter. The assembly shall provide a horizontal leveling adjustment of plus or minus five degrees and a vertical angle adjustment of 15 degrees above and below a standard luminaire angle position of 45 degrees. The reference line for measuring vertical angles shall be the vertical axis of the pole looking downward from the pole top.

Each luminaire shall be furnished with an instruction sheet which clearly shows installation procedures and instructions for proper luminaire tilt angle and aiming adjustments.

**(4) Ballast Module:**

The ballast and all major electrical components shall be combined into one pad-type unit, which shall be removable from the luminaire and replaceable by use of any easy operating latching device and a quick disconnect electrical plug.

**(5) High Pressure Sodium Ballast Operation:**

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The ballast shall be rated to the circuit voltage and size of the lamp specified. The regulator-type ballast shall be capable of starting the lamp at -20 degrees F and shall deliver the required lamp watts within plus or minus five percent with  $\pm 10$  percent variation in applied voltage. At rated line voltage, the ballast shall have a minimum power factor at end of life of 90 percent. The starting amperes shall be less than the operating amperes. The ballast shall provide the lamp voltage shown in the lamp table of Subsection 736-2.01(C). The ballast shall be prewired to the lamp socket and terminal board. The electrical connections shall be made by means of pre-wired quick disconnect plugs. The ballast shall be capable of operating for a six month period during a short circuit failure, lamp open, or end of life cycle without any measurable deterioration to the ballast.

**(6) Uplight Shield:**

The uplight shield shall be 0.100-inch aluminum sheet material mounted with a minimum of nine stainless steel screws. The shield's inside and outside surfaces shall have a polyester powder painted finish. The shield shall be the same color as the luminaire. It shall be configured to provide less than one percent uplight above the horizontal, as shown by independent test lab reports. The equivalent projected area shall be less than or equal to 4.15 square feet. The contractor shall furnish the Engineer with certified copies of the results of the independent test lab reports.

The entire luminaire shall have passed a 100,000-cycle, 2.25-g vibration test under normal operating conditions without mechanical failure of any part including the pole and foundation. All components shall be of non-corrosive material or have positive corrosion protection.

**(C) Lamps:**

The lamps shall be universal burning, clear, high pressure sodium type. Each lamp shall be clearly and permanently marked, giving the wattage and the American Standard Association number or the manufacturer's reference number. Lamps of the wattage specified shall conform to the following:

Wattage	Lamp Voltage	Min. Initial Lumens	Rated Life (hours)
150	55	16,000	24,000
250	100	30,000	24,000
310	100	37,000	24,000
400	100	50,000	24,000

**(D) Lighting Controls:**

**(1) Photo Electric Controls:**

The photo electric controls, hereinafter referred to as PEC, shall have a supply voltage rating of 105 to 285 volts AC, 60 hertz.

The nominal dimensions shall be 3.078 inches outside diameter and 2.219 inches maximum height. The operating temperature range shall be from -65 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.

When the north sky illumination in the area falls to the pre-set value, the lighting load shall be turned on.

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. The encapsulated surge protector shall have a spark-over value of two kilovolts and shall interrupt up to 10 kiloamperes of follow-through current without affecting the operating characteristics. The PEC shall meet the following electrical requirements:

Supply voltage:	105 – 285 volts, 50/60 Hz., AC
Photo cell coil:	120 volts, AC
Inrush current:	120 amperes at 110 volts 60 amperes at 240 volts
Lamp Loads:	
Incandescent	1,000 watts
Mercury vapor	1800 volt-amperes
Fluorescent	1800 volt-amperes
HPS	1800 volt-amperes
Relay contacts:	Single pole, single throw, normally closed
Turn on:	1.0 ± 0.2 foot candles
Turn on maximum:	1.8 foot-candles
Life at rated load:	5,000 on-off operations minimum 130 amperes @ 120 volts AC
Operating levels:	65 amperes @ 120 volts AC
Turn off Average:	3.0 foot-candles
Control power:	0.65 watts maximum (120 volts AC) 3.2 watts maximum (240 volts AC)

## **(2) 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



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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.

The contactor shall be of the mechanical armature type and shall consist of a 120-volt operating coil, a laminated core, a laminated armature, contacts, and terminals. The contacts shall be fine silver, silver-alloy, or other superior low contact resistance metal.

### **(3) 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.

## **736-2.02 Sign Lighting Materials:**

### **(A) General:**

Sign lighting fixtures and all necessary hardware shall conform to these specifications, and shall be UL approved. Each sign lighting fixture shall be designed for mounting at the top of the sign panels as shown on the plans on an overhead sign structure. The mounting and number of fixtures required per sign shall be as shown on the project plans. All sign lighting fixtures shall be supplied complete with lamps.

### **(B) High Pressure Sodium Fixtures:**

High pressure sodium sign lighting fixtures shall be designed for mounting at the top of the sign panel on an overhead sign structure. The fixture shall be of an enclosed design and shall be watertight and corrosion resistant. Each fixture shall consist of a housing with uplight shield, door, reflector, refractor, lamp, socket assembly, internal ballast, terminal block, quick connect harness and all necessary hardware. The fixture shall be UL listed and shall conform to the following:

#### **(1) Housing:**

The housing shall have a door designed to hold a refractor. Housings and doors shall be fabricated of die-cast aluminum. All external bolts, screws, hinges, hinge pins and door closure devices shall be stainless steel.

Each housing shall be drilled and tapped for 1-1/4 inch conduit at the center of the fixture nearest the sign panel.

Each housing shall be provided with holes as recommended by the manufacturer to permit condensed water to drain. Each hole shall be countersunk to a depth appropriate for the thickness of the housing.

The door shall be hinged to the housing on the side of the fixture away from the sign panel and shall be provided with two captive latch bolts or other closure devices. The door shall include an integral glare shield.

The juncture of the door and the housing shall be gasketed to provide a watertight and dust-tight joint. The gasket material shall be a minimum 3/8-inch seamless closed cell sponge EPDM meeting UL specification requirements for tensile strength and elongation after seven days aging at 113 °C.

**(2) Reflector:**

The reflector shall be one-piece hydroformed and shall be made from specularly finished aluminum protected with an electrochemically applied anodized finish. The reflector shall be designed so that water deposited on it due to condensation will drain away. The reflector shall be contoured to match the refractor design.

**(3) Refractor:**

The refractor shall be made from borosilicate heat resistant glass. The outer surface of the refractor shall be smooth and the inner surface shall contain the splitting and bending prisms. A single-piece weather resistant gasket shall seal the refractor to the housing. The refractor shall be so designed or shielded that no fixture luminance is visible when the fixture is approached directly from the rear and the viewing level is the bottom of the fixture. When a shield is used it shall be an integral part of the door casting.

**(4) Lamp:**

Each fixture shall be furnished with a 150-watt high pressure sodium lamp, ANSI code: S55SC-150, in accordance with the lamp table of Subsection 736-2.01(C)

**(5) Lamp Socket:**

Each lamp socket shall be a porcelain enclosed mogul type. The socket shell shall contain integral lamp grips to assure electrical contact under conditions of normal vibration. The center contact shall be spring-loaded. Shell and center contact shall be nickel plated brass. The socket shall be rated for 1,500 watts, 600 volts.

**(6) Ballast:**

The ballast for each HPS sign fixture shall be 100 percent copper wound and shall be designed for the characteristics and wattage of the

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lamp it is to operate, and it shall provide the proper starting voltage and operating waveforms, voltage and current.

Ballasts shall be of high power factor lag circuit design, capable of starting and operating one 150-watt high pressure sodium lamp within the limits specified by the lamp manufacturer.

Ballasts shall be 100 percent copper wound and have a Class H insulation system. Core laminations shall be M6 magnetic steel.

A  $\pm 10$  percent line voltage variation will not result in more than a  $\pm 10$  percent variation in wattage. Input wattage shall not exceed 188 watts. The power factor shall be over 90 percent throughout the life of the lamp.

The core-coil, starting aid and capacitor shall have a minimum ambient starting temperature of -40 degrees F and be capable of operating for a six month period during a short circuit failure, lamp open, or end of life cycle without any measurable deterioration to the ballast.

Ballasts shall have a design life of not less than 100,000 hours.

The input voltage for ballasts shall be as shown on the plans or as specified in the Special Provisions.

Each ballast shall consist of separate components, each of which shall be capable of being easily removed. Each component shall be provided with screw terminals, NEMA tab connectors or a single multi-circuit connector. All conductor terminals shall be identified as to the component terminal to which they connect.

Heat generating components shall be mounted so as to use the portion of the sign lighting fixture housing upon which they are mounted as a heat sink. Capacitors shall be located as far as practicable from heat-generating components or shall be thermally shielded to limit the case temperature to 75 °C.

Transformers and inductors shall be resin-impregnated for protection against moisture. Capacitors shall be metal cased and hermetically sealed.

### **(7) Terminal Block:**

Each fixture shall be provided with a barrier type terminal block for terminating field connections. The terminal block shall be secured to the housing and shall be provided with protection from water due to condensation. Means shall be provided for both fusing and disconnecting the input circuit. Fuses shall be 12/32-inch diameter, 1-1/2 inches long ferrule type and shall be UL listed. Fuses for use with 120-volt input fixtures shall be rated at six amperes, 250 volts; fuses for use with 240-volt and 480-volt input fixtures shall be rated at

three amperes, 600 volts. A quick connect wire harness shall be included for internal wiring.

**(8) Performance:**

When the fixture with its specified lamp is located so that the light center of the lamp is four feet in front of, one foot above and centered on a sign panel eight feet high and 16 feet wide, the ratio of the maximum to minimum illuminance level on the panel shall not exceed 4.65-to-one and the average to minimum illuminance ratio shall not exceed 2.75-to-one. In addition, the illuminance gradient shall not exceed two-to-one. The illuminance gradient is defined as the ratio of the minimum illuminance per one square foot of panel to that on any adjacent square foot of panel (square panel of the same size). The average maintained illumination level on the panel shall be 20 foot-candles.

**(9) Uplight Shield:**

The fixture shall be provided with an uplight shield that eliminates light above the horizontal plane. The shield shall be of the same manufacturer as the fixture, constructed of 0.060-inch aluminum sheet material and shall be mounted with a minimum of eight stainless steel screws. The shield shall be finished inside and outside with a baked polyester powder paint with a minimum 60 percent reflectance to match the luminaire. The shield shall be configured to provide zero light above the horizontal plane, as shown by independent test lab reports. The contractor shall furnish the Engineer with certified copies of the results of the independent test lab reports. The equivalent projected area shall be 1.4 square feet maximum. The shield shall flare at 45 degrees from the fixture housing to a point 1/4 inch below the lowest horizontal plane of the refractor.

**736-2.03 Load Center Cabinets:**

Load Center cabinets, including pole mounted cabinets shall have photoelectric controls and shall also include the 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 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. Cabinets shall have continuous welded seams on all outside seams.

Circuit breakers shall be molded case, thermal magnetic, bolt-on or plug-in type and shall be U.L. listed.

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Load center cabinets shall have a dead front panel to isolate all live electrical circuitry. The panel shall be fabricated from 14-gage sheet steel 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:**

Field adjustments of the lamp sockets shall not be made for horizontally-mounted type luminaires. The lamp socket shall be adjusted at the factory to achieve the light distribution as specified on the plans and in the Special Provisions.

After the poles have been erected and plumbed, the vertical-mounted type luminaires shall be aimed as described on the instruction sheet and specified herein. The contractor shall provide and utilize a manufacturer-supplied aiming device to adjust the tilt angle of each luminaire. The device shall be adjusted to the numerical factors given for each luminaire in the tilt-angle column of the project plans. Operation of the aiming device shall be as described on the instruction sheet.

The contractor shall maintain full nighttime operation of the existing lighting system during the duration of the construction project.

### **736-4 Method of Measurement:**

Luminaires will be measured as a unit for each luminaire furnished and installed.

Load center cabinets will be measured as a unit for each load center cabinet furnished and installed.

Sign lighting fixtures will be measured as a unit for each fixture 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.

The accepted quantities of sign lighting fixtures, measured as provided above, will be paid for at the contract unit price each, complete in place, which price shall be full compensation for the work described and specified herein and on the plans, including incidentals such as mounting hardware, electrical wiring and conduit on sign structure and

to adjacent pull box, circuit breaker disconnect, and any other equipment necessary to complete the work.

## **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, and removing and salvaging or reinstalling 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 six feet deep in the ground, be well tamped, and raked one 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 five 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.

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



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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.

### **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.

### **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.

**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).

**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.

**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:**

## SECTION 802

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 two 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.

#### **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 two 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.

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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 one 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. 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.

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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. 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 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. 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.

<b>TABLE 804-1</b>		
<b>Characteristics</b>	<b>Test Method</b>	<b>Requirement Average of 6 Samples</b>
pH	ARIZ 237	6.0 - 8.3
Soluble Salts: (PPM)	ARIZ 237	2000 Maximum
Calcium Carbonate:	ARIZ 732	8% Maximum
Exchangeable Sodium:	ARIZ 729	5% Maximum
Exchangeable Sodium: (PPM)	ARIZ 729	300 Maximum
P.I.	AASHTO T 90	5 - 20
Gradation:	ARIZ 201	% Passing
2 inch		100
1/2 inch		85 - 100
No. 40		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.



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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 six-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 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 Arizona Revised Statutes 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

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ash content, as determined by igniting a five 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 oats, wheat, rye or other grain 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 from the current season's crop and 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 with the name, weight and guaranteed analysis of the contents clearly marked. When a mixed fertilizer is specified, such as 5-10-5, 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 one 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 one cubic yard per 1,000 square feet

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and then watered until the ground is wet to a minimum depth of two 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 four 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. 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), except that mulching will not be required.

Unless otherwise specified in the Special Provisions, Class III seeded areas shall not be watered after planting.

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### **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 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



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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, Prepared Soil, 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.

Topsoil shall conform to the requirements of Subsection 804-2. Soil excavated from existing planting pits, trenches and beds which meet the requirements of Subsection 804-2 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.

**806-2.07            Water:**

Water shall conform to the requirements of Subsection 805-2.04.

**806-2.08            Chemical Fertilizer:**

Chemical fertilizer shall conform to the requirements of Subsection 805-2.06.

**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 two by two inches and lodge pole pine stakes shall have a diameter of two 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:**

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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:**

At the time of the preconstruction conference, the contractor shall submit to the Engineer seven copies of a list of all materials and equipment that it proposes to incorporate into the work. The contractor shall have materials and equipment correctly marked on each copy of 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, will be in accordance with the requirements of the project plans and these specifications. Plant material shall be approved as specified under Subsection 806-3.03. 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.

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

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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 or prepared topsoil conforming to the requirements of Subsection 806-2.04. 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 two 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 six 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, the contractor shall be responsible for maintaining and protecting all planting areas, as specified in Subsection 807-3.02, 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 Phase I, and disposed of by the contractor in accordance with Subsection 807-3.02.

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 six 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 Title 3, Chapter 2, Arizona Revised Statutes, Article 6, Section 3-377.



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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. 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 contract 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.

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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.

The contractor's responsibility for the work during landscaping establishment shall be in accordance with the requirements of Subsection 104.10. 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. 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.

Water for temporary offices, construction equipment and construction yard use shall be furnished and 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 Title 3, Chapter 2, Arizona Revised Statutes, 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

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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 as a single complete unit of work.

### **807-5                Basis of Payment:**

Landscaping establishment, measured as provided above, will be paid for at the contract lump sum price designated in the bidding schedule.

Partial payments may be made for landscaping establishment. Payment will be based upon the length of the landscaping establishment period, as specified in the Special Provisions, and the contract lump sum price for the item. Partial payment will be made only when the following work is completed prior to submittal of the monthly estimate:

- (1) The Engineer's list of necessary work from the prior inspection.
- (2) The contractor's list of proposed operations from its monthly work schedule.

If the contractor furnishes the water used during landscaping establishment, the cost shall be considered as included in the lump sum price bid for this contract bid item.

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.

## **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:

Main lines and/or pressure mains are defined as the piping under constant pressure. 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. Submains shall be the piping between a control valve (manual or automatic) and a pressure regulating device and not under constant pressure. Lateral piping is that on the discharge side of a control valve or pressure regulating device and not under constant pressure. 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

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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 one 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 three 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 three 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:**



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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 (Three Inches or Smaller):**

Gate valves three 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 B 62 with the exception of the stem which shall conform to ASTM B 371, 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 (Four Inches or Larger):**

Gate valves four 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 five 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.

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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 two-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 one-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 six 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 D 1784, Class 12454-B.

PVC pipe shall conform to the requirements of ASTM D 2241 for SDR-PR pipe and ASTM D 1785 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.

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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 D 2672.

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 D 2466 for Schedule 40 socket type fittings.

(b) ASTM D 2467 for Schedule 80 socket type fittings.

### **(2) Steel:**

Galvanized and black steel pipe shall conform to the requirements of ASTM A 53.

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 B 88. 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 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 shall conform to the requirements specified in the Special Provisions.

#### **808-3 Construction Requirements:**

#### **808-3.01 Materials and Equipment:**

At the time of the preconstruction conference, the contractor shall submit to the Engineer seven copies of the manufacturer's product sheets of the materials and equipment it proposes to use. 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, will be in accordance with the project plans and these 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 water distribution system equipment shall be installed in accordance with the printed instructions of the manufacturer, the project plans, Standard Specifications, and Special Provisions. The contractor shall provide the Engineer three copies, unless otherwise specified, of each manufacturer's installation instructions.

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 Phase I of the project or upon request by the Engineer.

All permits for installation or construction of any of the work included under Section 808, 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.

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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 phases I and II 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.



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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).

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). 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, 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 Arizona Test Method 201:

<b>Sieve Size</b>	<b>Percent Passing</b>
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:**

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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 these specifications. The supports shall receive protective paint finish as specified in Sections 610 and 1002 of these 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 Phases I and II. 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 these 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.

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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 one 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

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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 Phase I and for the duration of Phase II. The contractor may operate the system manually, in addition to the automatic mode and as necessary during Phase II, 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



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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 D 2751. Solvent cement conforming to the requirements of ASTM D 2235, shall be used on all ABS plastic pipe joints.

PVC pipe and fittings shall be manufactured in accordance with the requirements of ASTM D 3034. Solvent cement conforming to the requirements of ASTM D 2564 or elastomeric rubber ring gasket joints conforming to the requirements of ASTM D 3212, 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 for the fabric survivability rating shown on the project plans or specified in the Special Provisions.

### **809-3 Construction Requirements:**

#### **809-3.01 General:**

At the time of the preconstruction conference, the contractor shall submit to the Engineer seven copies of the manufacturer's product sheet of all materials and equipment that it proposes to incorporate into

the work. The contractor shall have materials and equipment correctly marked on each copy of the manufacturer's product sheet. These 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, will be in accordance with the project plans and these specifications. The contractor's failure to comply with these material submittal instructions will not constitute time extensions.

At the time of the preconstruction conference, the contractor shall submit to the Engineer seven copies of the list of all materials and equipment that it proposes to incorporate into the work. The contractor shall have materials and equipment correctly marked on each copy of the list. This list shall 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, will be in accordance with the project plans and these 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.

Construction of sewerage systems shall be governed by the applicable requirements of the Arizona Department of Environmental Quality.

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 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 edition of Arizona Department of Environmental Quality Engineering Bulletin No. 12.

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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 four feet or greater than six 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 six 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 D 2321.

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.

Materials for pipe bedding, haunching and initial backfill shall be placed in lifts of not more than eight 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 six inches below and on each side of the pipe and fittings. After excavation of all rock, six 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 four inches in depth under the pipe and shall be installed to insure 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 four 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 six inches below and on each side of the pipe. After excavation of all rock, a six-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 eight 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 four inches in maximum dimension and shall be water-settled or mechanically placed as approved by the Engineer. When completed,

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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 208-4.

### **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 of Engineering Bulletin No. 11, of the Arizona Department of Health Services and as follows:

Plug sewer line at lower end of section to be tested.

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.

Place a calibrated container at the average height of four 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.

Record the elapsed time to empty the container of water and calculate the loss rate in gallons per hour.

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 four 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:

Septic tanks will be measured either as a single unit of work, complete, or as a unit for each tank constructed.

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.

Manholes will be measured in accordance with the requirements of Subsection 505-4.

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

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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.

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. Geotextile fabric shall conform to the requirements of Subsections 1014-1 and 1014-8, 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 D 4751.

**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:

<b>COMPOST MATERIAL</b>	
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:**



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Riprap for cut and fill transitions designated on the plans shall be angular in shape and shall conform to the requirements of Section 913. 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. Rock mulch shall be in accordance with gradation C below, unless otherwise specified. Section 803 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.

Gradation C	
Sieve Size	Percent Passing
3 inch	100
2 inch	50 - 75
1 inch	10 - 20

810-2.04      Sand Bags:

Sand bags, when filled, shall measure approximately 24 inches long by 16 inches wide by four 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 D 6475	8	8*
Minimum Thickness** (inches)	ASTM D 5199	0.25	0.25
Minimum Tensile Strength (lbs./ft) ***	ASTM D 5035	75x75	100x100
*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, 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). Fibers

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shall remain evenly distributed over the entire area of the blanket after being placed on the slope.

Erosion control blankets shall be furnished in four-foot to eight-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 one inch wide by six inches long or two inches wide by eight 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.

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 ( $\pm 10$

percent) of the fiber at least six inches in length. Netting shall consist of long-term degradable, open weave, plastic or natural fiber containment mesh, with a maximum one-inch by one-inch grid. Sediment logs may also be filled with compost conforming to the requirements of Subsection 810-2.02. 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 ( $\pm 10$  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 one-inch by one-inch grid. Sediment wattles shall have nominal diameters of 9, 12, or 18 inches, with lengths from seven to twenty-five 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). 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 six inches. Blankets used to construct the fiber rolls shall have photodegradable plastic or biodegradable natural netting, with a maximum one-inch by one-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). 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 six 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 six inches onto the end of the next blanket prior to rolling.

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### **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.

### **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, 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 two inches below the height of the adjacent curb to allow drainage into the catch basin. When sediment depth behind the sand bags reaches three 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, 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 six-inch long staples in cohesive soil and eight-inch long staples in non-cohesive soil. A two-to-five 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 six-inch deep by six-inch wide trench shall be located at the top of

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the slope. The erosion control blankets shall be stapled to the bottom of the trench with staples spaced six 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 six inches with the upstream end on top. Staple the overlap across the end of the overlapping lengths with staples spaced six inches apart.

A six-inch deep by six-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 six 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 one-inch by one-inch by 46-inch hardwood stakes placed with a maximum spacing of two 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 two 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 two 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 four to six inches deep as shown on plans.

Logs placed on slopes shall be installed in a two-inch deep by five-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 two-inch deep by five-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 three feet apart, and driven approximately two feet into the ground. The ends of adjacent rolls shall be abutted together.

<b>Fiber Roll Spacing Table</b>	
<b>Slope (Horizontal to Vertical)</b>	<b>Spacing (feet)</b>
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.

Compost stabilization will be measured by the cubic yard of applied and tacked compost material.



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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, 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

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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:

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 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.

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.

The third payment of the lump sum price for mobilization will be made on the first estimate following completion of five percent of the contract. The amount paid for the third payment will be in accordance with Table 901-1.

The fourth payment of the lump sum price for mobilization will

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be made on the first estimate following completion of 10 percent of the contract. The amount paid for the fourth payment will be in accordance with Table 901-1.

The total sum of all payment shall not exceed the original contract amount bid 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.
* 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 and the retention of funds provisions in Section 109 shall not apply to the item of mobilization.

When other contract items are adjusted as provided in Section 104, 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.

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 Standard Specifications shall be submitted for all materials except for Subsection 902-2.08 Barbed Wire. 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 A 53, 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

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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 A 570, 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.

### **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 A 392, Class 1 coating. Aluminum-coated steel fabric shall conform to the requirements of ASTM A 491, 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 two-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 A 641, 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 one-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).

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 eight 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 one-inch pipe. Pipe shall be zinc-coated steel pipe conforming to the requirements of ASTM A 53, 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.



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Truss rods and tighteners for the gate frames shall conform to the requirements specified herein under Subsection 902-2.05.

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.

Gates shall be hung by at least two steel, ductile iron or malleable iron hinges not less than three 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.

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. 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 two 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

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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.

### **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.

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 Standard Specifications shall be submitted for all materials except for Subsection 903-2.02, Posts and Braces, and Subsection 903-2.04, Fencing Wire. Subsections 903-2.02 and 903-2.04 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 A 702. 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 A 702, 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.

#### **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 five inches apart and shall be either zinc-coated (Class |

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1) or aluminum-coated, conforming to the requirements of ASTM A 121.

### **(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 six inches apart and shall be either zinc-coated (Class 1) or aluminum-coated, conforming to the requirements of ASTM A 116.

### **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, except as specified herein.

Gates greater than five 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 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, two inch by two inch by four feet for the latch board and two inch by two inch by two 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.

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.

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

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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 five 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 four inches plus or minus for barbed wire fence and game fence and one 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 one 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



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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 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, 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.

Welded wire fabric shall conform to the requirements of Section 1003.

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.

All structural steel shall conform to the requirements of ASTM A 36, except that the anchor plate shall be made of steel conforming to the

requirements of ASTM A 572 or A 588. All structural steel shall be galvanized in accordance with the requirements of ASTM A 123.

#### **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.

The excavation for the concrete anchor block shall be to the neat lines shown on the project plans, with a maximum of three 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 one 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, tangent and flared 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, end anchors, and reflector tabs shall conform to the requirements of Section 1012 and the plans.

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Materials for tangent and flared guardrail terminals shall conform to the requirements of the approved manufacturer drawings and specifications. Only those tangent and flared guardrail terminals shown on the plans will be allowed.

Prismatic guardrail-mounted barrier markers shall conform to the requirements of Section 1008. Prismatic guardrail-mounted barrier markers shall be ultraviolet-resistant, and shall have a trapezoidal-shaped body in accordance with Standard Drawings.

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 3/16 inch. This material shall be configured into a rectangular body that is flat, curvilinear or tubular with a width of between three and four 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 ten square inches. The reflectorized surface for flexible vertical guardrail markers attached to the approach side of posts shall be three inches wide by five inches long.

Adhesive materials for applying reflective sheeting to guardrail terminals, metal or plastic guardrail reflector tabs, 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 pre-cut, 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 tangent and flared guardrail terminals, and reflective sheeting used for all other guardrail markers, including flexible guardrail markers and reflector tabs, shall conform to the requirements of Section 1007.

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.

Tangent and flared guardrail terminals, flexible guardrail markers, reflective sheeting products and inks approved for use 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 Transportation Research Center (ARTC), through its PRIDE program.

### **905-3 Construction Requirements:**

**905-3.01 General:**

The construction of the various types of guardrail, guardrail transitions, tangent and flared 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.

The various types of guardrail shall be constructed with wood blocks on either steel or wood posts, at the option of the contractor, except where the post materials to be used are specified on the plans. The same type of post shall be used in any one continuous length of guardrail.

All metal work 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 and 905-3.05. All metal cut in the field shall be cleaned and painted with two coats of zinc paint, in accordance with Section 1002.

Where field cutting or boring of wood posts and blocks is permitted, the affected areas shall be treated in accordance with the American Wood Preservers Association 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.

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.

**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 and driven the final 10 inches to grade, unless otherwise approved by the Engineer. Steel posts shall either be driven full depth, or placed in

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manually or mechanically dug holes and driven the final 10 inches to grade. 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 box culvert is at an elevation which would interfere with full depth post placement, the post shall be placed and anchored in accordance with the requirements of Subsection 905-3.06. Where the top surface of a culvert or other item is at an elevation which would interfere with full depth post placement, the post shall be eliminated and nested steel W-beam shall be placed in accordance with the requirements of Subsection 905-3.09.

The space around and under the posts placed in manually or mechanically dug holes shall be backfilled with moist soils placed in compacted lifts as approved by the Engineer.

Wood blocks shall be toe-nailed to the wood posts with one 16-penny galvanized nail on each side of the top of the block. Blocks shall be set so that the top of the block 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 at posts unless otherwise shown on the project plans. Rail elements at joints shall have full bearing. 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 installed with an approved driving head. The tubes shall not be driven with the wood post in place. If approved by the Engineer, foundation tubes may also be installed in drilled holes. When foundation tubes are placed in drilled 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 four inches above the ground as measured along a five foot cord.

**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.

Salvage foundation tubes for end anchors shall not be reused.

Where new bolt holes in rail elements are required, 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 in accordance with Section 1002.

**905-3.05 Reconstruct Guardrail:**

Existing guardrail, guardrail transitions, tangent and flared guardrail terminals, end anchors, and other guardrail systems shall be removed and reconstructed at the locations shown on the project plans, and in accordance with the provisions specified herein for new construction.

When reconstruct guardrail is specified, posts shall be completely removed and then reconstructed. When end anchors are removed, the existing concrete foundation shall be fully removed and the hole backfilled with moist soil in compacted lifts, as approved by the Engineer.

All guardrail components requiring removal shall be removed in such a manner as to prevent damage to and minimize the loss of the components.

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. Reconstructed tangent and flared guardrail terminals and end anchors shall be installed with new foundation tubes.

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.

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Existing posts, blocks, 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.

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 in accordance with Subsection 905-3.01.

### **905-3.06          Bolted Guardrail Anchors:**

Bolted guardrail anchors shall consist of bolting two steel brackets to the shortened post and to the box culvert roof as shown on the plans.

Where the elevation of the top surface of a concrete box culvert or other similar installation prevents the placement of a post of the specified length, the posts shall be shortened and anchored in accordance with the details shown on the plans.

Where field-cutting or boring of wood posts or blocks is required, the affected areas shall be treated in accordance with Subsection 905-3.01.

### **905-3.07          Rub Rail:**

Rub rail shall be installed in accordance with the details shown on the plans.

### **905-3.08          Guardrail Transitions:**

Guardrail transitions to concrete barriers shall be constructed in accordance with the details shown on the plans.

### **905-3.09          Nested Guardrail:**

This work shall consist of furnishing and constructing nested guardrail, Type 1, 2, or 3, including all materials, in accordance with the requirements of the project plans.

Nested guardrail consists of additional steel W-beam sections attached as an appurtenance to guardrail.

### **905-3.10          Tangent and Flared Guardrail Terminals:**

Tangent and flared guardrail terminals shall be installed in accordance with the manufacturer's specifications and approved drawings. When shown on the plans as alternatives, all tangent-type or flare-type terminals shall be from the same manufacturer without mixing brands. 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 five-foot cord.

Earthwork placement, grading, compacting, and bituminous 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 two-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.

The color of the retroreflective portion of the barrier markers and flexible delineators shall conform to the color of the adjacent edge line. Silver-faced guardrail reflector tabs shall be installed on the right hand side of all roadways and ramps. Yellow-faced tabs shall be installed on the left-hand side of one-way roadways and ramps. 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:**

Guardrail reflector tabs shall be installed on the W-beam at every sixth post, beginning with the post number shown in Table 905-1. On radial sections of guardrail, the reflector tabs shall be placed on the W-beam at every other post.



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In addition to the guardrail reflector tabs, flexible guardrail markers shall also be installed when the average project elevation, as shown on the plans, is greater than 4,000 feet. Flexible guardrail markers shall be installed on every 18th guardrail post beginning with the post number shown in Table 905-1.

The slotted part of reflector tabs shall be installed under the guardrail bolt head with the reflector facing oncoming traffic. The exposed ends of the slotted part of the tab shall be bent up against and then over the top of the bolt head.

### **(C) Tangent and Flared Guardrail Terminal Delineation:**

Delineation for tangent and flared 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 tangent and flared guardrail terminals used on a project with an average elevation of less than 4,000 feet, the contractor shall use either prismatic barrier markers, L-shaped or T-shaped markers, or flexible vertical delineators on the posts shown in table 905-1.

For tangent and flared guardrail terminals used on a project with an average elevation of greater than 4,000 feet, the contractor shall use either L-shaped or T-shaped markers, or flexible vertical delineators on the posts shown in table 905-1. Prismatic barrier markers shall not be used for projects greater than 4,000 feet in elevation.

When using L-shaped or T-shaped markers with the ET-PLUS in asphalt pavement areas, or with the SRT-350 regardless of pavement surface, the contractor shall substitute U-shaped markers or flexible vertical delineators (for steel I-beam posts) for post number two, regardless of project elevation.

The configuration of reflective sheeting object markers on the approach faces of the ET-PLUS, SKT-350, and FLEAT-350 shall conform to Standard Drawings. The dimensions of the object marker decals for the approach faces of the FLEAT-350, SKT-350, and ET-PLUS shall be modified as needed to fully cover the head configuration. The configuration and type of reflective sheeting object markers on the departure sides of the ET-PLUS, SKT-350, or FLEAT-350 shall conform to Standard Drawings.

The configuration of reflective sheeting on the approach side of the SRT-350 end-piece shall consist of three diamond shapes, each with side dimensions of four inches, vertically stacked corner-to-corner, and placed in the center of the approach face.

**TABLE 905-1  
GUARDRAIL DELINEATION POST PLACEMENT**

Terminal Type	Prismatic Barrier Marker Post Numbers	Begin Reflector Tabs and Flexible Markers* With Post Number
ET-PLUS or SKT-350	2, 4, 6, 8	10
SRT-350 or FLEAT-350	2, 4, 6	8
*Flexible markers shall only be used for elevations 4000 feet and above.		

#### **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 end posts, exclusive of tangent and flared guardrail terminals, end anchors, and guardrail transitions.

Tangent and flared 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.

Rub rail will be measured by the unit for each rail installed.

Nested guardrail, Type 1, 2, or 3, installed as an appurtenance to new guardrail, shall be measured by the linear foot of additional steel W-beam attached to the guardrail W-beam, using guardrail hardware required for a complete installation, as shown on the plans.

Bolted anchors for guardrail 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, brackets 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,

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tangent and flared 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 tangent and flared 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, blocks, 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 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 rub rail, measured as provided above, will be paid for at the contract unit price each, complete in place, including rub rail, back blockouts, and hardware as required.

The accepted quantities of nested guardrail, Type 1, 2, or 3, attached to the guardrail W-beam, and measured as provided above, will be paid for at the contract unit price per linear foot, complete in place.

The accepted quantities of bolted guardrail anchors, 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 steel brackets, hardware, excavation, backfill, removing and replacing surfacing, cutting and fitting steel beam posts or timber posts, drilling anchor bolt holes in steel posts, timber posts and box culverts, and disposal of surplus materials.

The accepted quantities of construct guardrail, guardrail transitions and end anchors from salvage; or reconstruct guardrail, guardrail transitions, tangent and flared guardrail terminals, and end anchors; 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. 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 for furnishing new posts, blocks, 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.

## **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 for Class B concrete.

#### **906-2.02 Steel:**

Reinforcing bars and structural steel shall conform to the requirements of Section 1003 and Section 1004, respectively. ASTM A 570, Grade 40 steel may be used as an alternate to ASTM A 36 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.

#### **906-2.04 Backfill:**

Backfill material shall conform to the requirements of Subsection 203-5.

#### **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.

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 PRIDE program. The use of precast cattle guards shall be limited to roadway locations with maximum longitudinal grades of six 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, as applicable.

Painting of structural steel shall be in accordance with the requirements of Section 610. Structural steel shall be painted with one coat of primer (Paint No. 1) in accordance with Section 1002. Painting of fence posts and gates shall be in accordance with the requirements of Section 902 or 903, 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).

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, 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 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

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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 D 41 shall be used.

### **907-2.03 Mop Coats:**

An asphalt which conforms to the requirements of ASTM D 449 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 D 173. 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 one 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.



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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 two 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 four gallons in each mop coat shall be used for each 100 square feet of surface, and on vertical surfaces, not less than five 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.

**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.

**908-2.03 Concrete Curing Compound:**

Curing compound shall be liquid membrane-forming compound conforming to the requirements of AASHTO M 148, Type I, Class A.

**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.

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Only those pre-fabricated detectable warning strips 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 PRIDE program.

### **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 six 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 six 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.

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. Forms unsatisfactory in any respect 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 insure 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 in advance of 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 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 in width or greater.

Longitudinal contraction joints shall be constructed in the center of sidewalk having a width greater than seven 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 two 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 two 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.

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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 provided by the Engineer.

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 one 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  $\pm 1/16$  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 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 as a unit for each sidewalk ramp constructed, including detectable warning strip. The limits of measurement for the various sidewalk ramp types will be shown on the plans.

#### **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, 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:**

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Concrete shall be utility concrete conforming to the requirements of Section 922. 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 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.

#### **909-3.02            Frames and Covers:**

New frames and covers shall be installed as specified under Subsection 909-3.01.

#### **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; however, at the contractor's option and with approval of the Engineer, adjustable extension rings conforming to the requirements of Subsection 505-3.03 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 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.

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 barrier shall conform to the requirements of Subsection 602-2.03.

Grout for the bedding of precast barrier shall conform to the requirements of Subsection 913-2.04.

Joint sealant barrier shall be latex sealing compound conforming to the requirements of ASTM C 834, applied as recommended in ASTM C 1193.

### **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 or extrusion
- (B) Cast-in-place by fixed forms
- (C) Precast

Concrete barriers shall present a smooth, uniform appearance in their final position, conforming to the horizontal and vertical lines shown on the project plans or ordered by the Engineer.



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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 and retaining walls shall be constructed by cast-in-place, fixed-form methods. Precast or slip-form methods will not be allowed.

Where 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 in accordance with the requirements of Subsection 601-3.05. Curing of concrete shall be in accordance with the requirements of Subsection 1006-6.

Barrier markers shall be installed in accordance with the details shown on the plans.

### **910-3.02        Cast-In-Place by Slip Form or Extrusion:**

#### **(A)        General:**

Concrete barriers constructed by using an extrusion 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 AASHTO M 241, except that sampling, testing, and acceptance of the concrete will be in accordance with the requirements of Section 1006. The contractor may be required to furnish evidence of successful operation of the extrusion machine or other equipment.

Slip form or extruded barrier will be considered not to require additional finishing if the surface meets the requirements of a Class II finish as described in Subsection 601-3.05 and the alignment is satisfactory. If the extruded 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. Barrier that cannot be refinished to meet the specifications for a Class II finish shall be removed and replaced at the contractors expense. Barrier that has unsatisfactory alignment and straightedge tolerance shall be penalized or replaced in accordance with these specifications.

The concrete shall be vibrated, rammed, tamped or worked with suitable equipment until the concrete has been consolidated in order to eliminate voids such as honeycombed surfaces. Further, the equipment shall be operated under sufficient uniform restraint to the forward motion to produce the required consolidation.

The concrete shall be of such consistency that after extrusion it will maintain the shape of the barrier without support.

The grade for the top of the concrete barrier shall be indicated by an offset guide line set by the contractor from survey marks established by the Engineer. The forming portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine to conform to the predetermined grade line. 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 extrusion machine may be operated on rails or forms or on existing pavement.

**(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 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.

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- (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 when placed adjacent to Portland Cement Concrete Pavement.

All other barrier dimensions shall not deviate by more than 3/4 inch from plan's alignment.

Those portions of the barrier not in compliance with the minimum requirements specified herein to be accepted at 75 percent of the unit price 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. 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 one 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 barrier shall be cast in accordance with the requirements of Section 601.

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 one 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 one 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.

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### **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.

##### **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.

#### **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 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 these specifications.

Shotcrete shall be mortar or concrete conveyed through a hose and pneumatically applied using either the dry mix process or the wet mix process.

The dry mix process shall consist of thoroughly mixing a proportional combination of dry fine aggregate and Portland cement; conveying the mixture through a delivery hose to a special nozzle where water is added and mixed with the other materials immediately prior to its discharge from the nozzle. The wet mix process shall consist of premixing by mechanical methods a proportional combination of Portland cement, 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 Section 1006.

**912-2.02 Aggregate:****(A) Fine Aggregate:**

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Fine aggregate shall conform to the requirements of Subsection 1006-2.03(B), except that it shall conform to the following gradation:

<b>Sieve Size</b>	<b>Percent Passing</b>
3/8 inch	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 10

### **(B) Coarse Aggregate:**

Coarse aggregate shall conform to the requirements of Subsection 1006-2.03(C), except that it shall conform to the following gradation:

<b>Sieve Size</b>	<b>Percent Passing</b>
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 may be used with the premixed mortar or the concrete and shall conform to the requirements of Subsection 1006-2.04.

### **912-2.04 Reinforcing Steel:**

Reinforcing steel bars or welded wire fabric shall conform to the requirements of Section 1003.

### **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 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 premixed material flow. 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 five pounds per square inch for each additional 50 feet of hose or fraction thereof.

**912-3 Construction Requirements:**

**912-3.01 Proportioning and Mixing:**

**(A) Dry Mix Process:**

Dry mix material shall consist of one part Portland cement to not more than four parts fine aggregate measured either by weight or by volume. The fine aggregate shall contain not less than three percent nor more than six percent moisture by weight.

The cement and fine aggregate shall be thoroughly mixed before being charged into the delivery equipment. If the contractor uses a drum-type mixer, the mixing time shall be not less than one minute. The mixed material shall be utilized promptly after mixing and any material that stands more than 45 minutes will be rejected and removed from the work site.

**(B) Wet Mix Process:**

**(1) Premixed Mortar:**

Premixed mortar shall consist of not less than 6.0 sacks of Portland cement per cubic yard, fine aggregate and water mixed to a desired consistency, generally to a slump in the range of 1-1/4 to four 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.



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### **(2) Concrete:**

Unless otherwise specified in the Special Provisions, the contractor shall determine the mix proportions and shall furnish concrete for pneumatic placement which contains a minimum of 658 pounds of Portland cement per cubic yard of concrete and which attains a minimum 28-day compressive strength of 3,000 pounds per square inch. Fine aggregate and coarse aggregate shall conform to the requirements of Subsection 912-2.02. The total mix shall contain, by weight, 15 to 20 percent coarse aggregate. In no case shall the slump be greater than four inches.

If ready-mixed concrete is used, it shall conform to the requirements of ASTM C 94.

### **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:**

Steel reinforcement shall be as shown on the project plans and shall conform to the requirements of Section 605.

### **912-3.05 Placement:**

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 two and five feet, to insure 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 three 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.

The contractor shall obtain three cores from each test panel in accordance with Arizona Test Method 317. The cores shall have a minimum diameter of three 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 Arizona Test Method 317. The cores shall have an average compressive strength of at least 3,000 pounds per square inch unless otherwise specified on the plans.

#### **912-3.07          Construction Joints:**

Construction joints shall be tapered to a shallow edge form one inch thick over a width of one foot, except where the joint will be subjected to compressive strength. If such is the case, square 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:**

After the shotcrete has been placed as nearly as practicable to the required thickness and shape outlined by forms and ground wires, the surface shall be checked with a straightedge and any low spots or depression shall be brought up to proper grade by placing additional shotcrete in such a manner that the finished surface shall be smooth

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and uniform.

Unless otherwise specified in the Special Provisions, 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 C 171.

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 C 309 and the application rate shall be one 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 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 these specifications.

Bank protection shall be dumped riprap, grouted riprap, wire tied riprap, riprap in wire baskets or gabions, and other types of bank protection and shall be constructed at the locations and as shown on the project plans.

### **913-2 Materials:**

#### **913-2.01 Rock:**

**(A) General:**

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 Arizona Test Method 210, modified to specify that testing shall be performed on three-inch maximum to plus No. 4 size material. If required by the Engineer, the contractor shall break an adequate amount of rock down to three-inch maximum size particles for performance of the necessary testing. 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, 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 size of each sample for dumped riprap and riprap (slope mattress) shall be at least five tons. The size 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 unsatisfactory by the Engineer shall be replaced with acceptable material at no additional cost to the Department.

**(B) Grouted Riprap:**

Gradation of the rock for grouted riprap shall be as specified in the Special Provisions or as shown on the project plans.

**(C) Wire Tied Riprap:**

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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.

### **(D) Dumped Riprap:**

Gradation of the rock for dumped riprap shall be as shown on the project plans or as specified in the Special Provisions.

Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the contractor at no additional cost to the Department.

### **(E) Gabions:**

Rock for gabions shall be well graded, varying in size from four to eight inches.

### **(F) 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.

Broken concrete may be used upon approval of the Engineer.

### **(G) Rail Bank Protection:**

Rock used to construct rail bank protection shall be well graded, varying in size from four to 12 inches.

## **913-2.02 Metal Items:**

### **(A) Wire Fabric:**

Welded wire fabric shall be galvanized and shall conform to the requirements of AASHTO M 55, 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 A 116, except that the minimum weight of the zinc coating shall conform to the requirements of ASTM A 641, 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 shall be submitted.

**(B) 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 shall be submitted.

**(C) Tie Wires:**

Tie wires shall be of good commercial quality and the size shall be as shown on the project plans, except that the minimum weight of the zinc coating shall conform to the requirements of ASTM A 641, Class 3. At the option of the contractor, approved wire fasteners may be used on gabions, slope mattresses, or wire fabric in lieu of tie wires.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

**(D) Steel Cable:**

Steel cable shall be zinc-coated steel structural wire rope conforming to the requirements of ASTM A 475, seven-wire strand, Class A, for the diameter shown on the plans.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

**(E) 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.

**(F) Soil Anchor Stakes:**

Soil anchor stakes shall be steel and of the length called for 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, two-inch diameter steel pipe conforming to the requirements of ASTM A 53, or 3-inch by 3-inch by 3/8-inch structural steel angles conforming to the requirements of ASTM A 36. Used rails, pipe 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 shall be submitted.

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### **913-2.03        Bedding Material:**

Bedding material shall consist of granular material having a maximum dimension of two inches and shall be free of clay or organic material.

### **913-2.04        Grout:**

Grout shall consist of one part Portland cement, three parts fine aggregate and one-fifth part hydrated lime, by volume. These materials shall be thoroughly dry mixed and sufficient water shall be added to provide a mixture of thick workable consistency.

Portland cement, fine aggregate and water shall conform to the requirements of Section 1006. Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

Grout that has been mixed more than one hour shall not be used. Retempering of grout will not be permitted.

### **913-2.05        Bank Protection Fabric:**

Fabric shall be supplied in accordance with and conform to the material requirements of Subsections 1014-1 and 1014-5, 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 D 4873. 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.

### **913-2.06        Sacked Concrete:**

Sacked concrete shall be utility concrete conforming to the requirements of Section 922, except that the minimum cement content shall be 376 pounds per cubic yard; the slump shall be from three to five inches; and the aggregate shall conform to the following gradation when tested in accordance with the requirements of Arizona Test Method 201:

Sieve Size	Percent Passing
2 inch	100
1/4 inch	45-89
No. 200	0-12.0

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 1.25 cubic feet. Sound, reclaimed sacks may be used.

### **913-3 Construction Requirements:**

#### **913-3.01 General:**

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.

#### **913-3.02 Bank Protection Fabric:**

When fabric is required, it shall be placed in the manner and at the locations shown on the project 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 four 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



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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.

### **913-3.03            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.

### **913-3.04            Wire-Tied Riprap:**

After installation of the lower portion of the wire mesh, rock shall be placed in accordance with the requirements of Subsection 913-3.03.

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 project plans.

### **913-3.05            Grouted Riprap:**

Rock for grouted riprap shall be placed in accordance with the requirements of Subsection 913-3.03. 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 insure 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 project plans. When a rough surface is specified, stone 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 F nor until the ascending air temperature rises above 35 degrees F. 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.**

At the option of the contractor, shotcrete conforming to the requirements of Section 912 may be furnished in lieu of grout.

**913-3.06 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 with the details shown on the project plans. Stone 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 project plans. Each anchor stake shall be fastened to the cover mesh with a tie wire.

**913-3.07 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.

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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 and diameter 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 with the project plan details. Stone 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 project 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 stone 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.

### **913-3.08        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 project plans and lightly trampled to cause them to conform with the earth face and with 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.

### **913-3.09 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.

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The completed rock fill shall be backfilled as necessary and the waste material disposed of as directed by the Engineer.

### **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.

### **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 913-3.09, will be paid for in accordance with the provisions of Subsection 109.04.

## **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, 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.

**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

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material requirements of sections 1014-1 and 1014-8.

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 D 4873. 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 three feet plus the burial depth in length and may be made of either wood or steel. Soft wood posts shall be at least three inches in diameter, or nominal two-inch by four-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, one 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 six 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 six 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 two 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 eight to ten inches of fabric is left at the bottom to be buried. The fabric shall be installed in the trench such that six inches of fabric is against the side of the trench and two to four 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, or as directed by the Engineer.

**915-4.02 Sediment Deposit Removal:**

Sediment deposits shall be removed when the deposit reaches



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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 these specifications.

### **916-2 Materials:**

Portland cement, water, and admixtures shall conform to the requirements of Section 1006 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. The designated size of coarse aggregate shall be No. 7, No. 67 or No. 57. At the option of the contractor, aggregate conforming to the requirements for Aggregate Base, Class 1, as shown in Table 303-1, may be furnished.

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. 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

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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 shall be submitted.

Concrete shall be Class B Portland cement concrete conforming to the requirements of Section 1006.

Welded wire fabric and wire ties shall conform to the requirements of Section 1003.

Steel bars for reinforcing, anchor stakes and trash racks shall conform to the requirements of Section 1003.

Miscellaneous structural steel shall conform to the applicable requirements of Section 1004.

Corrugated metal pipe shall conform to the requirements of Section 1010 and shall be fabricated with circumferential corrugations.

Preformed bituminous joint filler shall conform to the requirements of Subsection 1011-6.01.

**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 for embankment.

**917-3.02 Concrete:**

Concrete spillways, inlets and outlets shall be constructed in accordance with the requirements of Section 601. Reinforcing with wire mesh or steel bars where shown on the plans shall be placed in accordance with the requirements of Section 605.

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.

**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.

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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 for Class S concrete.

**919-2.02 Aggregate Base:**

Aggregate base shall conform to the requirements of Subsection 303-2 for any of the classes specified therein.

**919-2.03 Joint Filler:**

Joint filler shall conform to the requirements of Subsection 1011-6.

**919-2.04 Curing Compound:**

Curing shall be accomplished by any of the methods specified in Subsection 401-3.04(G), 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.

Aggregate base shall be placed and compacted in accordance with the requirements of Subsection 303-3, 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).

**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.

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### **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 - 921 BLANK:**

### **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. 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. 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 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 these 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 NSPS Certified Level III, 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.

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



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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.

The contractor shall furnish all traffic control, including flagging for survey and staking operations, the cost being considered to be included in contract bid item 9250001, CONSTRUCTION SURVEYING AND LAYOUT. Traffic control devices and procedures for construction surveying shall be in accordance with the requirements of the MUTCD and associated ADOT Supplement.

The Department will furnish field books to be used by the contractor for recording survey data and field notes. These books 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:**

Prior to beginning any survey operations, the contractor shall furnish to the Engineer, for approval, 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. Section 1150, Chapter 11 of the ADOT Construction Manual shall be used by the contractor as a guide in the preparation of this outline. The ADOT Construction Manual is available on the Department's website, through the Construction Group.

The Department will provide either traverse or control points for establishing an accurate construction centerline and will establish bench marks adjacent to this line for the proper layout of the work as described herein. Control points will be located on centerline at the beginning and ending of the project, and at all points of curve (P.C.), points of tangent (P.T.), tangents to spiral (T.S.), spirals to tangent (S.T.), and angle points. On long tangents, additional points will be provided for continuity of line.

Traverse points, when provided, will be as follows:

For horizontal control, the Department will run a traverse from which construction centerline can be established. The control points, delineated by iron pins, marks in concrete, or similar devices, will be located to minimize the likelihood of their destruction during construction activities. Coordinates of these points and/or ties to construction centerline will be provided.

For vertical control, the Department will 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 Engineer will be identified in the field to the contractor.

The contractor shall verify the accuracy of the traverse or control points established by the Engineer 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 Engineer in writing of the results of the verification.

The established initial right-of-way monuments shall be protected in place and re-established by the contractor, at no additional cost to the Department, if disturbed.

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).

Throughout the work, 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

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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.

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 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 furnished field books 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.

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 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 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 these 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.

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 of the several parts of the work.

### **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 1973, 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 1973, 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.
- (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 due compensation for any office survey work:

- (A) When information provided in the plans is sufficiently complete to allow any additional information necessary for

the complete layout of the project to be routinely calculated.

(B) When the contractor fails to inform the Engineer of discovered plan errors prior to the performance of any extra office survey work.

(C) That is included in any other existing pay item.

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 any 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 any other physical evidence which will verify 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 as a single complete unit of work.

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 by the lump sum 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, shall be the basis on which monthly progress payments shall be made. This schedule shall be subject to periodic review, at the request of either party, 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, the revised schedule will become the basis of payment.

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If additional staking and layout are required as a result of additional work ordered by the Engineer, such work will be paid under ITEM 9250101-ONE-PERSON SURVEY PARTY, ITEM 9250102 - TWO-PERSON SURVEY PARTY, ITEM 9250103 - THREE-PERSON SURVEY PARTY, ITEM 9250106 - SURVEY MANAGER, and ITEM 9250105 - OFFICE SURVEY TECHNICIAN. Payment will be made at the respective predetermined unit prices specified in the Special Provisions. 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, except that no mark-up will be allowed for profit and overhead. The Engineer will be the sole judge as to 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 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, Maintenance and Protection of Traffic.

No payment will be made for the resetting of stakes, references, bench marks, and other survey control.

The amount per hour for a survey manager and an office survey technician shall include all necessary office supplies and equipment, such as calculators and computers.

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  $70 \pm$  five 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 (or the construction phase of the work where landscape establishment is involved). 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, 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:**

This work will be measured for payment as a single complete unit of work.

**926-5                Basis of Payment:**

Payment for this work will be made at the contract lump sum price, which price shall be full compensation for the item complete, including all labor, materials, equipment, 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 five percent of the original contract amount is earned, 50 percent of the amount bid for Engineer's Field Office will be paid.



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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 and the retention of funds provisions in Section 109 shall 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 three 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:

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.

The remaining forty percent will be paid in approximately equal monthly payments based on the expected use of the laboratory.

The adjustment provisions in Section 104 and the retention of funds provisions on Section 109 shall not apply to this item.

## **SECTION 928 GROUND-IN RUMBLE STRIP:**

**928-1 Description:**

The work under this item 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 Construction Requirements:**

Rumble strips shall be constructed by mechanically milling or grinding grooves into new or existing asphalt concrete pavement. The grooves shall be constructed with a cylindrical 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

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to remove such material by means of grinding to a controlled line and grade. The equipment used shall be capable of removing the existing asphaltic concrete 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. 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 one 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.

### **928-3 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.

### **928-4 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.

**SECTION 1001 MATERIAL SOURCES:****1001-1 Description:**

The work under this section shall consist of the procuring of borrow, subbase and base materials, mineral aggregates for concrete structures, and mineral aggregates for surfacing materials specified for use 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 specifications.

Unless otherwise specified, pits and quarries shall be so excavated that water will not collect and stand therein. 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, for any contractor-furnished source proposed for use. Environmental analyses prepared for contractor-furnished sources, and approved by the Department later than January 1, 1999, will be acceptable.

A list of sources known by the Department to have approved environmental analyses will be kept on file at the ADOT Materials Group, mail drop 068R, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740. The contractor may propose the use of these sources as a contractor-furnished source without the requirement of submitting a new Environmental Analysis, provided that all other requirements of this section have been met.

It shall be the responsibility of prospective bidders to conduct any necessary on-site investigations and/or explorations, and to satisfy themselves that the quantity and/or quality of material exists in the sources listed above. No representation regarding quality or quantity of materials is made by the Department.

**1001-2.01 Definitions:**

All material sources shall fall into one of the following two categories:

Department-Furnished Source  
Contractor-Furnished Source

A Department-furnished source shall be defined as a material source for which the Department has prospected, taken samples, tested,

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prepared an Environmental Analysis, secured the rights for its use, including ingress and egress, and which may be available for the contractor's use on a specific project.

A contractor-furnished source shall be defined as any source other than a Department-furnished source, and shall include commercial operations as defined below.

A commercial operation shall be defined as a material source at which the owner or producer has been located for at least the preceding 12 months prior to award of contract, and routinely engaged during regular business hours on a consistent basis in the processing and selling of sand, rock, ready mixed Portland cement concrete, asphaltic concrete and other similar products to all parties. The company shall have an Arizona retail sales tax license. The contractor shall furnish documentation to the Engineer that the source is an active commercial operation. This documentation may include evidence of sales or other data acceptable to the Engineer. A commercial source, whenever referenced in the specifications, shall be considered to be a commercial operation, as defined herein.

Should the contractor elect to set up a concrete or asphalt batch plant within or adjacent to a commercial operation for the exclusive supply of contract items, the contractor's operation shall not be considered part of the commercial operation.

### **1001-2.02 Material Sources in Flood Plains:**

The use of material sources situated in the 100-year flood plain of any stream or watercourse, and located within one mile upstream and two miles downstream of any highway structure or surfaced roadway crossing, shall be limited as follows:

- (A) Existing commercial operations, as defined in Subsection 1001-2, shall not be utilized as a source of borrow.
- (B) No new source or existing non-commercial source will be approved for any materials except as specified in the following subparagraph (C).
- (C) 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 prior to the date of advertisement for bids on the Department project.
- (D) Material sources located on Native American Indian Reservations will be considered for use based on an individual analysis. The analysis shall include a review of applicable land use plans, flood plain management plans, environmental plans, applicable laws and regulations

pertaining to Indian Reservations, and an engineering analysis of the effects on any highway facility or structure. The contractor shall obtain from the Native American Tribal Council all permits, licenses, and approvals and present to the Department for review. The Department will review each request on a case by case basis.

The location of any new material source or existing non-commercial material source proposed for use on the project shall be reviewed by the appropriate agency having flood plain management jurisdiction for the area in which the proposed source is located. The contractor shall obtain a letter from the agency addressed to the Engineer certifying that the location of the proposed source conforms to the requirements of the specifications.

Contractors seeking a flood plain material source are cautioned that Section 404 of the Clean Water Act may prevent use of the source unless an appropriate permit is first obtained from the U.S. Army Corps of Engineers.

If a flood plain source is being considered for use, the contractor is advised to contact Environmental Planning Services of ADOT to insure that the source will be obtainable within the required time frame.

### **1001-3 Department-Furnished Sources:**

#### **1001-3.01 General:**

The use of a Department-furnished source is not mandatory.

#### **1001-3.02 Information Available:**

The approximate location, the kind of material, the name and address of the owner, the amount of royalty charges, and other relevant information will be available for review from the Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740.

The available information should be considered at most as only a starting point for those prospective bidders choosing to use the source.

It shall be the responsibility of prospective bidders to conduct any necessary on-site investigations and/or explorations, and to satisfy themselves that the quantity and/or quality of material exists in the source in the event their bids are predicated upon the use of the source. Whether a source will in fact yield material of sufficient quantity or quality to meet the specific requirements may not have been determined.

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Prospective bidders are advised that an agency having jurisdiction over the source, such as the Forest Service, Bureau of Land Management, Bureau of Reclamation, the State Land Department, etc., or the owner, as a condition to the use of the source, may have imposed certain obligations. The contractor who uses such a source shall assume full contractual responsibility for any and all of these obligations imposed either by the agency having jurisdiction or by the owner. Specific requirements may or may not be available, and prospective bidders considering such a source are urged to make themselves fully aware of any and all requirements.

It shall be the responsibility of the bidder to ensure that the Environmental Analysis complies with existing laws, rules, and regulations.

### **1001-3.03      Usage of Materials:**

Except as hereinafter provided, materials removed from Department-furnished sources shall be used only for the specific project and purpose for which the source was obtained.

Should the contractor desire to remove and use material other than that specified for use, prior approval by means of a supplemental agreement shall be obtained. The contractor shall furnish the Engineer with evidence that the owner of the source has agreed to such use. The Department reserves the right to disapprove any request when it is considered to be in the best interest of the Department to conserve such material for future use.

If the Department approves the removal and use of such material, the quantity of the material removed and the quantity of any waste material resulting from its removal will be deducted from the estimated quantity of material shown to be available.

### **1001-3.04      Royalty Charges:**

The amount of the royalty charges and the name and address of the party to whom royalties are to be paid will be available from the Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740.

Prior to the time of final payment, the contractor shall furnish the Engineer with evidence such as an endorsed canceled check that all royalty charges have been paid. In the event that royalty charges have not been paid, the Department reserves the right to make such payment and to deduct the amount of such payment from monies due the contractor.

The final billing and payment for material extracted from sources under the jurisdiction of the State Land Department will include a small administrative charge based on the total amount of royalties due for materials removed.

Upon receipt of the final billing from the Department of Transportation, the contractor shall mail a check, payable to the State Land Department, addressed as follows:

Arizona Department of Transportation  
Field Reports Services  
206 South 17th Avenue  
Phoenix, Arizona 85007

### **1001-3.05      Performance Bonds:**

If Department-furnished sources are under the jurisdiction of either the State Land Department or the Bureau of Land Management, the contractor shall secure a performance bond. A fully executed copy of the bond shall be furnished the Engineer along with evidence that a fully executed copy has been sent to the State Land Department or the Bureau of Land Management.

The form of the Performance Bond will be included in the proposal pamphlet. For pits under the jurisdiction of the Bureau of Land Management, the surety shall be a company listed under "Surety Companies Acceptable on Federal Bonds." This list is published annually as of July 1 in the Federal Register.

Performance bonds shall be conditioned upon the compliance with the requirements of the State Land Department and the Bureau of Land Management and the requirements of the specifications for the clearing of pit sites, the removal of material and the cleaning up of pit sites.

Copies of fully executed performance bonds shall be mailed as follows:

State Land Commission	Bureau of Land Management
State Land Department	Manager, Land Office
1624 West Adams Street	2400 Valley Bank Center
Phoenix, Arizona 85007	Phoenix, Arizona 85073

### **1001-3.06      Sampling and Testing:**

The results of any sampling and testing accomplished by the Department will be available from the Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009-3740.

### **1001-4          Contractor-Furnished Source:**

#### **1001-4.01      Approval Requirements:**

##### **(A) General:**

The contractor shall promptly advise the Engineer as to the source that it proposes to use.



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The contractor acknowledges that all the conditions set forth in this subsection must be met before the source may be used.

Other than sampling and testing, the requirements of this subsection shall be completed prior to initiation of any activities which disturb the existing conditions at the proposed source.

The contractor further acknowledges that no additional compensation will be made on account of any delays in preparing or modifying the environmental analysis, obtaining approval for the use of a contractor-furnished source, or the failure to obtain approval of a contractor-furnished source. An extension of contract time may be granted only in accordance with Subsections 104.12 or 1001-4.01(B)(4).

### **(B) General Requirements For Approval:**

The use of a contractor-furnished 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 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 this condition shall be completed prior to initiation of any activities which substantially disturb the existing conditions at the proposed source.
- (2) Except for commercial operations, the contractor has furnished the Engineer with evidence that he has secured the rights to the source, including ingress and egress.
- (3) The Department has determined that the material from the proposed contractor-furnished source not only meets the requirements, but is also compatible with the established project design criteria developed by the ADOT Materials Group and based on the soil support value of the embankment; and, except for commercial operations, the sampling and testing herein specified has been satisfactorily completed.
- (4) For a contractor-furnished source which is not a commercial operation as defined in Subsection 1001-2.01, the contractor shall notify the Arizona Department of Agriculture, in accordance with the Arizona Native Plant Law, at least 30 days prior to any clearing operations of less than 40 acres on private land, 60 days prior to clearing operations of 40 or more acres on private land, and 60 days prior to any clearing of state land, regardless of size. If the Engineer is convinced that the contractor has made every effort to comply with the provisions of the Arizona Native

Plant Law in contacting the Department of Agriculture, the Engineer will increase the number of contract days by the amount of time required for action by the Department of Agriculture. The increase will not exceed 20 contract days and will be concurrent with any increase allowed for the preparation of the Environmental Analysis.

**(C) Historical and Cultural Resources:**

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.

**1001-4.02 Testing Requirements:**

The contractor shall furnish equipment and personnel and shall obtain representative samples of the material under the supervision of the Engineer. At the option of the contractor, the material shall be tested by either the Department or by a testing laboratory approved by the Department.

If testing is performed by a testing laboratory, the contractor shall arrange for the samples to be delivered to the testing laboratory. Tests shall be performed using appropriate test procedures referred to in the sections of the specifications in which the specific material requirements are described.

The contractor shall make the arrangements necessary to see that the testing laboratory submits the results of the tests to ADOT Materials Group. The contractor shall submit to ADOT Materials Group sufficient material from the samples taken so that ADOT Materials Group may test the materials and verify the results.

The cost of all sampling and testing, including the cost of supervision by the Engineer, shall be borne by the contractor until the testing has been satisfactorily completed.

Exploratory sampling and testing activities conducted prior to the Department's approval shall be limited to the minimum amount of vegetation removal and surface disturbance required to obtain representative samples. The contractor shall not produce material, mobilize crushing equipment or clear a worksite prior to approval of the Environmental Analysis.

The use of material from commercial operations will require written approval by the Engineer. No approval shall be assumed, nor will it be made, until the Department has determined that the material not only meets the specified requirements, but is also compatible with the established project design criteria developed by ADOT Materials Group, and based on the soil support value of the embankment materials and the structural coefficients of the base and surfacing materials.

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Every effort will be made by the Department to advise the contractor as quickly as possible that the source it proposes to use has been either approved or disapproved. The contract time will not be adjusted because of any time required by either the contractor or the Department to sample and test the material and to determine the quality of the material.

### **1001-5            Blank**

### **1001-6            Special Access:**

If there is a Department-furnished source, the point(s) at which special access to a controlled access highway may be allowed will generally have been considered and, if appropriate, will be shown on the project plans. Such access shall be in accordance with the requirements specified in the Special Provisions and on the project plans.

The contractor may make a request to the Engineer to approve special access to a controlled access highway if:

- (1) Special access is not shown on the project plans,
- (2) The contractor elects not to furnish material from the Department-furnished source, or
- (3) There is no Department-furnished source.

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 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 which has been disturbed shall be restored to the condition existing prior to the contractor's operations.

The decision by the Engineer to deny a request by the contractor will be considered to be final.

### **1001-7            Operations at Source:**

#### **1001-7.01        General Requirements:**

The requirements of Subsection 1001-7 shall not apply to commercial operations.

In Department-furnished sources the contractor shall conduct its operations in such a manner as to preserve available materials in excess of project requirements.

The contractor shall notify the Engineer in advance of operations at the source. Notice shall be given before and after clearing and stripping and before and after cleaning up.

#### **1001-7.02 Clearing and Stripping:**

Before beginning stripping, the contractor shall clear and grub the source as necessary to prevent the contamination of materials to be used in the work. Clearing and grubbing shall be in accordance with the requirements of Section 201, except that the resulting surface need not be leveled and vegetable matter need not be separated from any overburden which the Engineer determines to be unsuitable for any future use and which is to be wasted.

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation and other debris removed, the contractor shall comply with the requirements of Title 36, Public Health and Safety, Chapter 6, Article 8, Air Pollution, of the Arizona Revised Statutes and with the Rules and Regulations for Air Pollution Control, Article 7, adopted by the Arizona Department of Environmental Quality pursuant to the authority granted by the Statutes.

Burning will be permitted only after the contractor has obtained a permit from the Arizona Department of Environmental Quality, and from any other Federal, State, County or City Agency that may be involved.

When stripping is required, overburden shall be removed to the extent necessary to remove all undesirable materials and shall, at all times, be kept stripped at least five feet beyond the working face of the area being excavated.

#### **1001-7.03 Extraction of Materials:**

Materials shall be removed from the source in a workmanlike manner. In order to produce acceptable material in the amount and gradation required, it may be necessary for the contractor to do any or all of the following, along with any other similar operations usually associated with the extraction, processing and production of the particular material being produced:

- Move materials from one area to another.
- Perform additional screening.
- Remove, wash and waste material.
- Blend materials.

## SECTION 1001

Revise crushing methods.

Remove deleterious materials such as clay balls, roots and sticks.

If the Engineer determines that the material in a source is stratified, all material except borrow shall be removed for the full depth in such a manner as to produce a uniform blend of the material. Placing the material from different areas and depths into a surge pile and removing material from the surge pile by cutting through the pile will be acceptable provided that a uniformly blended material is obtained.

Material sources located in drainage channels such as washes, river beds, etc., may experience seasonal variations in the depth of ground water. In order to produce the quantity of material estimated to be available in Department-furnished sources, the contractor may be required to work below the water table.

### **1001-8                    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.

### **1001-9                    Cleaning Up:**

The requirements of this subsection shall apply to contractor-furnished sources to the extent that they are required by the Environmental Analysis and by the owner. The requirements of Subsection 1001-9 shall not apply to commercial operations.

All overburden and other undesirable materials removed and all piles of waste materials resulting from operations in Department-furnished sources shall be deposited within the excavated area of the source and the material shall be leveled as directed. In the event that the Department-furnished source contains material needed for future use, the placement of such materials within the excavated area shall be as directed. All debris shall be removed and disposed of and, if directed, all open test holes shall be filled. The sides of Department-furnished

sources shall be sloped and smoothed so that livestock can enter and leave the excavated area safely. Unless otherwise specified, all haul roads constructed to Department-furnished sources shall be obliterated and, as far as practicable, the ground left in as good condition as it was prior to hauling.

#### **1001-10 Method of Measurement and Basis of Payment:**

Except as may be otherwise specifically provided for in this section or elsewhere, no measurement or direct payment will be made for any costs involved in the procuring of materials. Such costs shall be considered as included in the cost of contract items.

### **SECTION 1002 PAINT:**

#### **1002-1 Requirements:**

##### **(A) General:**

All paints furnished shall be ready-mixed at the manufacturer's plant, except for aluminum paint and zinc paint, which shall be mixed at the project site or fabricator 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 paint specifications as listed herein.

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 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.

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.

When painting structural steel, the supplier or manufacturer of the primer, intermediate coat, and topcoat of paint shall be the same and the paint coats shall be compatible with each other, forming a complete paint system.

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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, 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.

### **(B) Three-Paint Coating System:**

All three-paint coating systems, as specified in Subsection 1002-2.01, shall be ready-mixed at the manufacturer's plant.

Only approved paint systems will be allowed for use on structural steel. Paint systems approved in accordance with Subsection 1002-3(B) 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 Transportation Research Center (ATRC), through its PRIDE program. Paint supplied by an approved manufacturer with a different product code from that which was previously evaluated and approved will require evaluation to determine if it is acceptable. It is the responsibility of the manufacturer to submit the necessary samples for paint system evaluation and approval. Approved paint systems will be removed from the list if it is determined through long-term performance testing or by their performance in the field that they are unacceptable.

### **(C) Aluminum and Zinc Paints:**

Aluminum and zinc paints shall be mixed at the project site or fabricator just prior to application.

For safety purposes, aluminum paint shall be mixed only as needed and any unused paint shall be safely discarded and shall not be stored.

### **(D) Acrylic Emulsion Paint:**

Paints approved in accordance with Subsection 1002-3(D) 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 Transportation Research Center (ATRC), through its PRIDE program. For paints supplied which are not shown on the Approved Products List, a Certificate of Analysis showing conformance to Subsection 1002-2.04 for each lot or batch of paint supplied shall be submitted to the Engineer in accordance with Subsection 106.05, prior to its use.

## **1002-2 Paints:**

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. Lead, lead compounds, soluble barium compounds or hexavalent chromium compounds shall not be added to any paint formulas specified under this section.

The use of halogenated solvents is not permitted.

Raw materials used in the paint formulas shall conform to the specifications designated by ASTM or by Federal or Military Specifications listed herein, except as otherwise specified herein. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitutions for any specified material shall be made without the written consent of the Engineer.

A three-paint system shall be water-borne and each paint shall be ready-mixed by the manufacturer. The volatile organic content of the mixed paint shall not exceed 2.1 pounds per gallon.

Zinc paint shall be in accordance with Subsection 1002-2.02.

Aluminum paint shall be water-borne and shall be mixed in accordance with Subsection 1002-2.03.

All paints will be sampled and tested in accordance with Subsection 1002-3.

#### **1002-2.01 Three-Paint Coating System:**

##### **(A) General:**

A three-paint coating system shall include a primer (Paint Number 1), intermediate coat (Paint Number 2), and topcoat (Paint Number 3) from the same system. A three-paint coating system will be tested as a complete system in accordance with Subsection 1002-3(B).

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 D 4212 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.

##### **(B) Paint Number 1 - Primer:**



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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.

### **(C) 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.

### **(D) 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 also 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.

When specified, a two-part aluminum paint conforming to Subsection 1002-2.03 shall be applied as the topcoat. The two parts shall be mixed in accordance with the manufacturer's label directions prior to use.

## **1002-2.02 Zinc Paint:**

### **(A) General:**

This paint shall be a zinc-dust, zinc-oxide primer conforming to the requirements of Federal Specification TT-P-641G, Type III, zinc dust, zinc oxide phenolic resin primer modified to conform to the requirements (1) through (8) below, and as otherwise specified herein.

The Volatile Organic Compound or solvent portion of the vehicle shall conform to the following requirements by volume:

- (1) Solvents with an olefinic or cyclo-olefinic type of unsaturation shall not exceed five percent.
- (2) The total of aromatic compounds with eight or more carbon atoms in the molecule, except ethylbenzene shall not exceed eight percent.
- (3) The total of ethylbenzene, toluene, and branched-chain ketones shall not exceed 20 percent.

- (4) A solvent which may be classified into more than one of the above groups shall be considered a member of the group having the lowest allowable concentration.
- (5) The total of (1), (2), and (3) shall not exceed 20 percent.
- (6) The volatile solvents shall contain no benzene or halogenated compounds.
- (7) All paints shall be completely miscible with mineral spirits conforming to Grade II of Federal Specification TT-T-291.
- (8) Mineral spirits, conforming to Grade II, of Federal Specification TT-T-291 shall be the preferred thinner for all paints specified in this Subsection. If necessary, other paint thinners conforming to the requirements of (1) through (6) above may be used.

If modified colors are required, pigments which do not contain lead, lead compounds, soluble barium compounds, or hexavalent chromium compounds shall be used in amounts not exceeding ten percent of the total pigment weight and replacing an equal weight of zinc oxide.

This specification covers a ready-to-mix or semi-prepared primer for use on, or repair of, galvanized metal surfaces. The primer ingredients shall be furnished in two separate containers, one consisting of a liquid (zinc oxide-vehicle) and the other of zinc dust which is to be added to the zinc oxide-vehicle just prior to use. When the entire amount of zinc dust from one container is mixed with all of the zinc oxide-vehicle from another container, a primer, conforming to all the requirements of this specification, shall result. The mixed primer shall normally be of a gray color characteristic of the composition, unless otherwise specified.

#### **(B) Proportions:**

One gallon of zinc dust, zinc oxide primer meeting this specification will have the following characteristics, when the minimum figures are met, and the pigment is a mixture of 80 percent zinc dust and 20 percent zinc oxide:

Constituent	Composition by Volume (gallons)	Composition by Weight (pounds)
Zinc dust	0.1445	8.50
Zinc Oxide	<u>+ 0.0455</u>	<u>+ 2.12</u>
Total Pigment	0.1900	10.62
Nonvolatile Vehicle	<u>+ 0.3544</u>	<u>+ 2.99</u>
Total Solids	0.5444	13.61
Volatile (thinner and Drier)	<u>+ 0.4556</u>	<u>+ 2.99</u>
Total primer (gallon)	1.0000	16.60

#### **(C) Qualitative Requirements:**

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The mixed primer shall meet the following qualitative requirements:

<b>Characteristics</b>	<b>Min.</b>	<b>Max.</b>	<b>Test Method</b>
Pigment, percent by weight of primer	64	67	ASTM D 723
Water, percent by weight of primer	----	0.1	ASTM D 3960
Coarse particles and skins, percent by weight of pigment	----	4	ASTM D 185
Consistency, Krebs-Stormer, shearing rate 200 r.p.m.	72	92	ASTM D 562
Time to set to touch, hours	0.5	4	ASTM D 1640
Time to dry, hours	----	18	ASTM D 1640
Weight per gallon, pounds	16.4	----	ASTM D 1475
VOC of mixed primer, lbs/gal.	----	3.5	ASTM D 3690

### **(D) Pigment:**

The pigment composition in the mixed primer (except when colors other than gray are specified) shall be in accordance with the following:

<b>Ingredients</b>	<b>Percent by Weight</b>	
	<b>Min.</b>	<b>Max.</b>
Zinc Dust (ASTM D 520, Type I)	79	89
Zinc Oxide (ASTM D 79, American Process, Lead Free)	19	21

Upon analysis, the zinc dust shall show not less than 94 percent metallic zinc by weight. The pigment, extracted from the zinc oxide-vehicle and ignited, shall show on analysis not less than 98 percent zinc oxide by weight.

The total pigment (zinc dust plus zinc oxide) in the mixed primer shall contain a minimum of 74 percent metallic zinc and a minimum of 18 percent zinc oxide by weight. The sum of the percentage by weight of metallic zinc and zinc oxide in the total pigment of the mixed primer shall be not less than 97.

### **(E) Vehicle:**

The vehicle shall consist of 100 percent phenolic resin spar varnish, suitable for grinding with zinc oxide, and shall have an oil-to-resin ratio of approximately 2 to 1 by weight.

The resin shall be 100 percent paraphenyl phenol-formaldehyde resin of the fortifying type, meeting the requirements of Federal Specification TT-R-271.

The vegetable oils shall consist of equal parts by volume of tung oil meeting the requirements of Federal Specification TT-T-775 and linseed oil conforming to Federal Specification TT-L-90.

The volatile solvent used shall be any solvent system complying with Subsection 1002-2.02(A) and applicable air pollution regulations by weight per gallon, Subsection 1002-2.02(C). Antiskinning agents may be present.

The vehicle shall contain not less than 50 percent solids by weight when tested according to Federal Standard No. 141, Method 4051.

**1002-2.03      Aluminum Paint:**

This paint is a two-part waterborne leafing aluminum paint formulated for use on properly prepared metal surfaces exposed to the air. Aluminum paint shall conform to California D.O.T. Specification Formula PWB-160 or as otherwise specified herein. This paint may be utilized for the finish coat when the aluminum color is specified on the plans. Aluminum paint must be compatible with the underlying paint coats. The quantity of aluminum paint mixed during any one day shall be limited to the quantity to be used during that day. The paint shall be mixed in accordance with the manufacturer's label directions prior to use.

For safety purposes, aluminum paint shall be mixed only as needed and any unused paint shall be safely discarded and shall not be stored.

**(A)      Composition:**

This paint shall be supplied with 1.5 pounds of the specified aluminum paste to one gallon of vehicle.

**(B)      Pigment:**

a) Ingredients:

Water dispersible Aluminum Paste (1)

b) Characteristics:

Non-volatile content, percent, ASTM D 480      72 minimum

**(C)      Vehicle:**

a) Ingredients:	% by Weight
Acrylic Latex (2)	89.31
2,2,4-Trimethylpentanediol-1,3-monoisobutyrate	4.44
Ammonium Hydroxide (28%)	0.47
Defoamer (3)	0.35

Preservative (4)		0.05
Thickener (5)	} } Premix	approx. 0.12
2-(2-Methoxyethoxy)ethanol		5.26
b) Characteristics:		Requirements
Density, grams per milliliter, ASTM D-1475		1.01 to 1.03
Nonvolatile content, percent, ASTM D2369, B		36.5 - 38.5
Viscosity, centipoises, ASTM D2196, Test Method A (50 RPM, #3 spindle)		900 - 1200
High-shear viscosity, ASTM D-4287, 0 to 5-P cone, shear rate 12 000 s <sup>-1</sup>		0.5 to 0.7
pH		9.0 - 9.5

- (1) Hydro Paste® 830 (Silberline)
- (2) Maincote® HG-54D (Rohm and Haas)
- (3) Foamaster® AP (Henkel)
- (4) Proxel® GXL (ICI Americas)
- (5) Acrysol® RM-8W (Rohm and Haas)

**(D) Mixed Paint:**

a) Characteristics:	Requirements
Nonvolatile Content, volume percent (calculated using maximum mix water)	33 - 35
Drying time, 100 μm wet film, ASTM D-1640	
set to touch, hours	½ maximum
dry through, hours	1 maximum

**(E) Mixing Procedures:**

Add 0.5 gallons of potable water to the aluminum paste and mix to a smooth, lump-free consistency. Slowly stir in the vehicle. Mix well, but avoid incorporating air into the paint. Strain the mixed paint through a double layer of cheesecloth prior to use. THE PAINT MUST BE MIXED FRESH EACH DAY. DO NOT STORE MIXED PAINT. DO NOT PLACE MIXED PAINT IN SEALED CONTAINERS.

**(F) Application:**

The mixed paint shall be applied to a total dry film thickness of at least 2.0 mils. This coating is intended for spray application; however, limited application can be made by brush. Paint should not be applied when the ambient or surface temperature is above 100 °F, or below 50 °F, or when the relative humidity exceeds 75 percent.

**(G) Clean-up:**

Use tap water for clean-up. Ten percent ammonia, acetone, or other suitable solvent may be used to remove dried paint from spray guns and other equipment. All applicable governmental pollution regulations shall be adhered to during cleanup and for the disposal of unused paint.

#### **1002-2.04 Acrylic Emulsion Paint:**

Acrylic emulsion paint shall be water-borne and conform to the requirements of Federal Specification TT-P-19 Paint, Acrylic Emulsion Exterior. Acrylic emulsion paint will be tested in accordance with Subsection 1002-3(D).

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 two-foot by two-foot, 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 at random and tested for conformance to any of the chemical and physical characteristics and properties as declared by the manufacturer on the respective product data sheet. Also, complete three-paint 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) Three-Paint Coating System:**

Paint coatings in Subsection 1002-2.01 will be tested as a complete three-paint coating system. Paint systems shall have an evaluation rating of 100 or greater, as described below, after being weathered in accordance with the requirements of ASTM D 4587 and ASTM G 53 in the Q-U-V Accelerated Weathering Tester (Fluorescent UV/Condensation Apparatus). Paint systems will be tested as follows:

1. Paint coatings will be applied to cold rolled steel panels (ASTM D 609, Type 3, ASTM A 366). The paint will be thinned to  $75 \pm 2$  Ku consistency using demineralized water. Three coats, each approximately 2 mils thickness are applied to each of four

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panels according to ASTM D 823. 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 500 hours and another at 750 hours. The last two panels shall be removed at 1000 hours.
3. Paint systems will be evaluated on the basis of six measures of degradation which may be found to occur under the conditions of exposure. For each measure, a rating scale of from one to five points will be applied. A rating of one point indicates the poorest performance and five points indicate the best performance. The rating from each measure is multiplied by a weighting factor which represents the relative importance of that measure. The product is a score for that measure. The sum of the scores for all measures is the overall score for the system. All paint systems shall have an overall score of 100 or higher.
  - A) Cracking/Flaking: Three ASTM standard test methods are used to provide a measure of the degree of degradation in this area: ASTM D 660, ASTM D 661, and ASTM D 772. The definitions and illustrations contained in these methods are used in combination for the rating scale. A weighting factor of three will be applied to the results of these tests.
  - B) Blistering/Flaking: Two ASTM methods are combined for this rating scale: ASTM D 714 and ASTM D 772. A weighting factor of three will be applied to the results of these tests.
  - C) Corrosion: A rating scale is derived from ASTM D 610 for evaluating the degree of rusting. A weighting factor of three will be applied to the results of this test.
  - D) Chalking/Erosion: Two ASTM methods are combined for this rating scale: ASTM D 4214 and ASTM D 662. A weighting factor of three will be applied to the results of these tests.
  - E) Adhesion: The tape test is based on ASTM D 3359 and the rating scale is from the Classification of Adhesion Test Results under Test Method B. A weighting factor of five will be applied to the results of this test.
  - F) Flexibility: This is a modified version of ASTM D 522 using a 1-1/4 inch mandrel. The degree of cracking observed after bending is used for the rating. A

weighting factor of five will be applied to the results of this test.

Paint may also be tested in accordance with the requirements of Arizona Department of Transportation Testing procedures, ASTM, and Federal Test Method Standard Number 141.

**(C) Aluminum and Zinc Paint:**

Aluminum and zinc paint vehicles may be tested in accordance with the requirements of ASTM D 2621, ASTM D 2805, ASTM E 1347, and Federal Test Method No. 141.

**(D) Acrylic Emulsion Paint:**

Acrylic emulsion paints will be tested in accordance with the following procedure:

**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 G 53, for 300 hours utilizing UVB-313 lamps and the exposure cycle as specified in Subsection 4.3.5.2 of Federal Specification TT-P-19. The paint weathered in this manner shall show no appreciable change in color or appearance due to fading, chalking, or material reaction.

**2) TT-P-19 Requirements:**

All performance requirements listed in Section 3 of Federal Specification TT-P-19 will be met as specified when tested according to the applicable test methods as specified in Section 4 of Federal Specification TT-P-19.

**3) Adhesion:**

The acrylic emulsion paint will be applied to a concrete test specimen or to the final concrete surface and subjected to one or both of the methods of adhesion testing described below, after a minimum period of 7 days of sunlight after application.

Adhesion will be measured in accordance with the requirements of ASTM D 3359. When Test Method A is used, a rating of 3A will be required. When Test Method B is used, a rating of 2B will be required.

**4) Testing:**

Random inspection testing of the completed paint finish will be performed by the Engineer according to the above performance requirements. Non-compliance with these test results will require remedial action which may include substitution of the paint supplied,



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modification to the application plan, removal and repainting of the non-compliance section(s), or other action as deemed appropriate 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 this Section. Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

When reinforcing steel is delivered to the 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.

### 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 AASHTO M 31 (ASTM A 615).

Where shown on the plans, the bars shall be Grade 60.

Where Grade 60 is not specified on the plans, Grade 40 shall be used if immediately available. If Grade 40 is not immediately available, Grade 60 may be used exclusively or in combination with Grade 40 provided that the conditions under which the grades are used in combination are acceptable to the Engineer and further provided that there is no additional cost to the Department.

### 1003-3 Wire:

Steel wire used as spirals or ties for reinforcement in concrete shall conform to the requirements of AASHTO M 32.

### 1003-4 Welded Wire Fabric:

Welded wire fabric used as reinforcement in concrete and mortar shall conform to the requirements of AASHTO M 55.

### 1003-5 Epoxy Coated Reinforcing Bars:

#### 1003-5.01 Steel:

Steel reinforcing bars shall conform to the requirements of Subsection 1003-2.

**1003-5.02      Epoxy for Coating:**

A list of powdered epoxy resins which have passed prequalification tests, as described in AASHTO M 284 "Epoxy Coated Reinforcing Bars," and which may be used if the material is applied and cured in the same manner as that used to coat the test bars in the original powder prequalification test may be found on the Department's Approved Products List. Copies of the most current version are available on the internet from the Arizona Transportation Research Center (ATRC) through its PRIDE program.

Prequalification testing may be performed by the National Bureau of Standards, State laboratories, or qualified private independent laboratories.

The powdered epoxy resin selected by the contractor and furnished by the manufacturer shall be of the same material and quality as the resins listed on the Approved Products List.

The approved powders are based on specific reinforcing steel preparation and powder application and curing methods and these identical methods shall be followed during fabrication.

The coating manufacturer shall supply the purchaser with a Certificate of Compliance conforming to the requirements of Subsection 106.05 which properly identifies 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 for repairs made by the contractor of areas of the coating damaged during fabrication and/or handling in the field.

**1003-5.03      Application of Coating:**

The coating applicators 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 Steel Structures Painting Council-Surface Preparation Specification No. 10 (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

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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.

The epoxy coating shall be applied as a smooth uniform coat. After curing, the coating thickness shall be  $10 \pm 2$  mils. 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 ASTM G 12.

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 Compliance from the coating applicator, in accordance with the requirements of Subsection 106.05 with each shipment of coated steel. The Certificate of Compliance shall (1) verify that the coated items and coating material have been tested in accordance with the requirements of these specifications, (2) state the actual test results for each requirement, (3) state that the test results comply with the requirements, and (4) state 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 for compliance with the requirements of coating thickness, continuity of coating and coating cure and the testing required under Flexibility of Coating, in accordance with the requirements of this subsection.

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 reinforcement bars which do not meet the requirements for coating thickness, continuity of coating, coating cure or flexibility of coating shall not be repaired.

Reinforcement 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 two 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.

The repair of coating breaks shall be limited to bars on which the total of the defective coating areas does not exceed five percent of the surface area of the reinforcement bar. Bars with greater than five percent damage shall be replaced or alternately, stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

### **SECTION 1004 STRUCTURAL METALS:**

#### **1004-1      General Requirements:**

Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted.

#### **1004-2      Structural Steel:**

Structural carbon steel shall conform to the requirements of AASHTO M 183 (ASTM A 36).

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 four inches thick with 50,000 pounds per square inch minimum-yield point shall conform to the requirements of AASHTO M 222 (ASTM A 588).

#### **1004-3      Steel Structural Rivets:**

Steel structural rivets shall conform to the requirements of AASHTO M 228 (ASTM A 502).

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### **1004-4 Bolts, Nuts and Washers:**

High strength structural steel, bolts and washers shall conform to the requirements of Section 604-2.03.

Bolts and nuts other than high strength steel bolts shall conform to the requirements of ASTM A 307, 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 A 36).

### **1004-5 Steel Forgings:**

Carbon steel forgings shall conform to the requirements of AASHTO M 102 (ASTM A 668, Class C).

### **1004-6 Castings:**

Carbon steel castings shall conform to the requirements of AASHTO M 103 (ASTM A 27, Grade 65-35). Gray iron castings shall conform to the requirements of AASHTO M 105 (ASTM A 48, Class 30B). Malleable iron castings shall conform to the requirements of ASTM A 47, 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 B 22, Copper Alloy UNS No. C 91100). Rolled copper-alloy bearing and expansion plates shall conform to the requirements of AASHTO M 108 (ASTM B 100, 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 A 595, Grade A.

### **1004-9 Steel Pipe:**

Steel pipe shall conform to the requirements of ASTM A 53, 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 shall be submitted.

**1005-2 Sampling of Bituminous Material:**

Sampling of bituminous material shall conform to the requirements of AASHTO T 40. 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. The pressure aging temperature shall be as specified below:

<b>PG Asphalt Binder</b>	<b>Pressure Aging Temperature</b>
PG 76-XX or PG 70-XX	110 °C
PG 64-XX, PG 58-XX, or PG 52-XX	100 °C

If PG 76-22 TR+ asphalt binder is used, it shall conform to the requirements of Table 1005-1a.

A minimum of seven working days prior to the start of asphaltic concrete production, the contractor shall provide the Engineer a one-gallon sample of the proposed asphalt binder and a Certificate of Analysis, conforming to the requirements of Subsection 106.05, showing complete asphalt binder testing. Laboratory-prepared samples will not be acceptable. Asphaltic concrete production shall not begin until the Engineer determines the acceptability of the proposed asphalt binder.

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 asphalt cement will be adjusted by the percentage shown in Table 1005-1. Should the

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asphalt cement be in reject status, the contractor may, within 15 days of receiving notice of the reject status of the asphalt cement, 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 applicable 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 insure homogeneity. If emulsified asphalt has separated due to freezing, it shall not be used. Emulsified asphalt shall not be used after 30 days from delivery.

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 material may 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.



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**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: $G^*/\sin \delta$ , kPa	T 315	$\geq 1.00$ 0.90-0.99 0.70-0.89 $< 0.70$	100 95 85 70 (1)
Dynamic Shear of RTFO Binder: $G^*/\sin \delta$ , kPa	T 315	$\geq 2.20$ 2.00-2.19 1.60-1.99 $< 1.60$	100 95 85 70 (1)
Dynamic Shear of PAV Binder: $G^*\sin \delta$ , kPa	T 315	$\leq 5000$ 5001-5500 5501-7000 7001-8000 $> 8000$	100 95 85 75 65 (1)
Creep Stiffness of PAV Binder: S, Mpa	T 313	$\leq 300$ 301-330 331-450 451-600 $> 600$	100 95 85 75 65 (1)
m-value at 60 sec.	T 313	$\geq 0.300$ 0.270-0.299 0.230-0.269 $< 0.230$	100 95 80 65 (1)

(1) Reject Status: The pay adjustment applies if allowed to remain in place.

**Notes:**

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.

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.

The information presented in this table does not apply to asphalt cement used for tack coats.

**TABLE 1005-1a**  
**PG 76-22 TR+ ASPHALT BINDER**

Test Property	Test Method	Requirement	Test Result	Percent of Contract Unit Price Allowed
Solubility in Trichloroethylene, %, minimum	ASTM D 2042	97.5	-----	-----
Softening Point, °C, minimum	AASHTO T 53	60	≥ 60 57-59 < 57	100 85 70 (1)
Elastic Recovery, @ 10 °C, %, minimum	AASHTO T 301	55	≥ 55 50-54 < 50	100 85 70 (1)
Phase Angle (δ), @ 76 °C @ 10 rad/sec, degrees, maximum	AASHTO T 315	75	≤ 75 76-83 > 83	100 85 65 (1)

(1) Reject Status: The pay adjustment applies if allowed to remain in place.

**Notes:**

PG 76-22 TR+ asphalt binder shall contain a minimum of 8 percent crumb rubber and a minimum of two percent SBS (styrene-butadiene-styrene) polymer.

PG 76-22 TR+ asphalt binder shall conform to the requirements of AASHTO M 320 and, in addition, shall meet the requirements specified above.

Table 1005-1 will also apply for PG 76-22 TR+ asphalt binder.

Should the bituminous material be deficient on more than one of the properties listed in Tables 1005-1 and 1005-1a, the pay adjustment will be the greatest reduction to the contract unit price specified considering individual test results.

The pressure aging temperature for PG 76-22 TR+ asphalt binder shall be 110 °C.

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 hold water when stored or disposed of above ground.

**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)
(1) Reject Status: The pay adjustment applies if allowed to remain in place.		
<p>Note: Since volatile solvents utilized in the manufacture of MC Liquid Asphalt may volatilize in varying amounts during normal 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% of the contract unit price is allowed.</p>		

**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	Ariz. 502				55		
Residue: (4) Residue, %, minimum (5)		55	60	63	65	57	57

## Notes:

- (1) T 59 is AASHTO
- (2) Distilled water will be used instead of the two percent sodium oleate solution.
- (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 ( $G^*/\sin \delta$ ) 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)**

<b>Tests on Emulsion:</b>	<b>Test Method</b>	<b>Requirement</b>
Viscosity, Saybolt Furol seconds @ 50 °C (122 °F), range	AASHTO T 59	100-400
Storage Stability, 24 hours, % maximum	AASHTO T 59	1
Demulsibility, 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 °C (350 °F), % minimum	AASHTO T 59	66
Oil Distillate to 176.7 °C (350 °F), Volume of Emulsion, % maximum	AASHTO T 59	0.5
<b>Tests on Residue from Distillation:</b>		
Penetration, 25 °C (77 °F), 100 grams, 5 seconds, range in 0.1 mm	AASHTO T 49	40-100
Ductility, 4 °C (39.2 °F), 10 mm/minute, cm, minimum	AASHTO T 51	35
Elastic Recovery by means of Ductilometer, 25 °C (77 °F), % minimum	AASHTO T 301	55
(1) The introduction of polymer must occur before emulsification.		

**TABLE 1005-3b  
POLYMERIZED HIGH FLOAT EMULSIFIED ASPHALT (1)**

Tests on Emulsion:	Test Method	Requirement	
		HFE-150P	HFE-300P
Viscosity, Saybolt Furol seconds @ 50 °C (122 °F), 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 °C (400 °F), % minimum	AASHTO T 59	65	65
Oil Distillate to 176.7 °C (350 °F), Volume of Emulsion, % maximum	AASHTO T 59	7.0	7.0
<b>Tests on Residue from Distillation:</b>			
Penetration, 25 °C (77 °F), 100 grams, 5 seconds, range in 0.1 mm	AASHTO T 49	150-300	300 +
Float Test at 60 °C (140 °F), seconds, minimum	AASHTO T 50	1200	1200
Ductility, 25 °C (77 °F), 5 cm/minute, cm, minimum	AASHTO T 51	100	N/A
Elastic Recovery by means of Ductilometer, 4 °C (39.2 °F), % minimum	AASHTO T 301	25	25
<p>(1) The introduction of polymer must occur before emulsification.</p> <p>(2) Distilled water will be used instead of two percent sodium oleate solution.</p>			

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**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 D 2007		30		30		30		30
Test on Residue: (1) Weight Change, %			6.5		4		3		2
Viscosity Ratio: (2)			3		3		3		3
Notes: (1) Residue will be obtained in accordance with the requirements of AASHTO T 240. (2) Viscosity Ratio: <u>Viscosity of residue at 140 ° F, centistokes</u> Viscosity of recycling agent at 140 ° F, centistokes									

**TABLE 1005-5  
EMULSIFIED RECYCLING AGENTS**

Tests on Emulsified Recycling Agent	AASHTO Test Method Except as Shown	Requirement			
		ERA-1	ERA-5	ERA-25	ERA-75
Viscosity: Saybolt Furol, 77 ° F, seconds range	T 59	15 - 40	15 - 100	15 - 100	15 - 100
Miscibility	T 59	Passes	Passes	Passes	Passes
Sieve Test: %, maximum	T 59 (1)	0.10	0.10	0.10	0.10
Particle Charge	T 59	Positive	Positive	Positive	Positive
Residue: (2) Residue, %, minimum (3)		60	60	60	60

- Notes:
- (1) Distilled water will be used instead of the two percent sodium oleate solution.
  - (2) Residue will be obtained in accordance with the requirements of Arizona Test Method 504 and shall conform to all 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.



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**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 PG 76-XX PG 70-XX PG 64-XX PG 58-XX PG 52-XX PG 76-22 TR+	275 - 400	-----	232 233 235 236 238 229
Liquid Asphalt MC-70 MC-250 MC-800 MC-3000	105 - 175 140 - 225 175 - 225 215 - 290	90 - 155 125 - 200 160 - 225 200 - 260	253 249 245 241
Emulsified Asphalt RS-1 CRS-1 RS-2 CRS-2 CRS-2P SS-1 CSS-1 HFE-150P HFE-300P	70 - 140 125 - 185 125 - 185 125 - 185 125 - 185 (1) 70 - 160 70 - 160 ----- -----	-----	240
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
(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 air-entraining admixtures, chemical admixtures, and a supplementary cementitious material.

The contractor shall determine the mix proportions and shall furnish concrete which conforms to the requirements of these 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 harmful 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 these specifications.

**1006-2 Materials:****1006-2.01 Hydraulic Cement:**

Hydraulic cement shall consist of either Portland cement or Portland-pozzolan cement.

Portland cement shall conform to the requirements of ASTM C 150 for Type II, III, or V. However, at the option of the manufacturer, processing additions may be used in the manufacture of the cement, provided such processing additions have been shown to meet the requirements of ASTM C 465, and the total amount of such material used does not exceed one percent of the weight of the Portland cement clinker.

Portland-pozzolan cement shall conform to the requirements of ASTM C 595 for Type IP (MS).

Hydraulic cement shall not contain more than 0.60 percent total alkali. The word alkali as used in these specifications shall be taken as the sum of sodium oxide and potassium oxide calculated as sodium oxide.

Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted.

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 for any reason has become partially set or which contains caked lumps shall not be used.

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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.

### **1006-2.02      Water:**

The water used shall be free from injurious amounts of oil, acid, alkali, clay, vegetable matter, silt or other harmful matter. Water shall contain not more than 1,000 parts per million of chlorides as Cl and not more than 1,000 parts per million of sulfates as SO<sub>4</sub>.

Water shall be sampled and tested in accordance with the requirements of AASHTO T 26. 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 and coarse aggregate shall be subject to five cycles of the sodium sulfate soundness test in accordance with the requirements of AASHTO T 104. The total loss shall not exceed 10 percent by weight of the aggregate as a result of the test. 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.

When aggregates show potential for alkali silica reaction (ASR), as indicated by expansions of 0.10% or greater at 16 days after casting when tested in accordance with ASTM C 1260, sufficient mitigation for the expansion shall be determined in accordance with ASTM C 1567.

Mill tailings or material from mine dumps shall not be used in the production of fine or coarse aggregate.

The handling and storage of concrete aggregate shall be such as to minimize segregation or the intermixing and contamination with foreign materials. The Engineer may require that aggregates 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 material from becoming intermixed.

When aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and level. The bottom one-foot layer of aggregate shall not be disturbed or used.

The handling and storage of concrete aggregate for Class P concrete at the job 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. Stockpiles shall be constructed by first distributing the aggregate over the entire base and then building upward in successive

layers not more than five feet in depth. Aggregate shall not be dumped or spilled over the side of the pile. When a conveyor is used to stockpile aggregate, it shall be equipped with an adequate rock tremie or rock ladder to reduce segregation and it shall be moved continuously across the stockpile. The distance the material drops from the tremie shall not exceed 10 feet. Aggregate shall be distributed over the stockpile so that the formation of conical piles higher than 10 feet is prevented.

Contamination of concrete aggregate for Class P concrete by contact with the ground at the job site shall be positively prevented. The contractor shall take the necessary measures to prevent such contamination. Such preventive measures shall include, but not necessarily be limited to, 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.

The following test methods will be used to evaluate the quality of aggregates for concrete:

Sampling	Arizona Test Method 105
Reducing field samples to testing size	AASHTO T 248
Potential for Alkali Silica Reaction (ASR)	ASTM C 1260 & C 1567
Clay lumps and friable particles	AASHTO T 112
Lightweight particles	AASHTO T 113 (See Note)
Organic impurities	AASHTO T 21
Aggregate gradation	Arizona Test Method 201
Soundness (Sodium Sulfate)	AASHTO T 104
Mortar Strength	AASHTO T 71(See Note)
Sand equivalent	AASHTO T 176
L.A. abrasion	AASHTO T 96
Fractured Coarse Aggregate Particles	Arizona Test Method 212
Note: AASHTO T 113 and T 71 are modified as specified in Subsections 1006-2.03 (B) and (C).	

#### **(B) Fine Aggregate:**

Fine aggregate shall be a natural 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:

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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:

Clay lumps and friable particles	AASHTO T 112	0.5%
Lightweight particles	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*)
* Only material that is brownish-black, or black, shall be considered coal or lignite.		

The total amount of all deleterious substances listed in the table above shall not exceed 1.25 percent by dry weight.

Fine Aggregate shall meet the following gradation requirements when tested in accordance with Arizona Test Method 201.

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. Aggregates producing a color darker than the standard color shall be rejected unless the material passes the mortar strength specified in the following paragraph:

Fine aggregate shall be made into mortar and subjected to testing under 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 Ottawa sand having a fineness modulus of  $2.40 \pm 0.10$ .

### (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 Arizona Test Method 201, shall conform to the appropriate size designation of AASHTO M 43, except as shown below.

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:

Clay lumps and friable particles	AASHTO T 112	0.3%
Lightweight particles	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	Arizona Test Method 201	1.0%
* Only material that is brownish-black, or black, shall be considered coal or lignite.		

The total amount of all deleterious substances listed in the table above shall not exceed 1.25 percent by dry weight.

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.

#### **1006-2.04      Admixtures:**

##### **(A)      General Requirements:**

The contractor shall furnish Certificates of Compliance conforming to the requirements of Subsection 106.05 for each type of admixture furnished.

Calcium chloride as a separate admixture shall not be acceptable.

All concrete admixtures 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.

Admixtures shall be uniform in properties throughout their use in the work.

If more than one admixture is used, the admixtures shall be compatible with each other so that the desired effects of all admixtures used will be realized.

##### **(B)      Air-Entraining Admixtures:**

Air-entraining admixtures shall conform to the requirements of ASTM C 260.

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Only those air-entraining admixtures 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 PRIDE program.

Air-entraining admixtures having a chloride concentration of 10,000 parts per million (one percent by mass of the admixture) or less, as determined in accordance with Arizona Test Method 738, are acceptable unless otherwise specified.

### **(C) Chemical Admixtures:**

Chemical admixtures shall conform to the requirements of ASTM C 494.

Only those chemical admixtures 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 PRIDE program.

Chemical admixtures having a chloride concentration of 10,000 parts per million (one percent by mass of the admixture) or less, as determined in accordance with Arizona Test Method 738, are acceptable unless otherwise specified.

### **(D) Supplementary Cementitious Material (Fly Ash, Natural Pozzolan, and Silica Fume):**

Supplementary cementitious materials shall be approved prior to their use in accordance with Materials Policy and Procedure Directive "Certification and Acceptance of Hydraulic Cement, Fly Ash, Natural Pozzolan, and Silica Fume".

Fly ash and natural pozzolan shall conform to the requirements of ASTM C 618 for Class C, F, or N mineral admixture, except that the loss on ignition shall not exceed 3.0 percent.

Silica fume shall conform to the requirements of ASTM C 1240.

When a supplementary cementitious material with a calcium oxide content greater than 15 percent is used, or when the Special Provisions specify sulfate resistant concrete, the cement intended to be used shall be tested for sulfate expansion in accordance with ASTM C 1157 and ASTM C 1012. For moderate sulfate resistance, the maximum expansion shall be 0.10 percent at six months. For high sulfate resistance, the maximum expansion shall be 0.05 percent at six months and 0.10 percent at one year.

When Class C fly ash is used, the cement intended to be used shall be tested for sulfate expansion in accordance with ASTM C 1157 and

ASTM C 1012 and shall have a maximum expansion of 0.05 percent at six months and 0.10 percent at one year.

1006-2.05      **Concrete Curing Materials:**

Liquid membrane forming compound shall conform to the requirements of AASHTO M 148. 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.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1006-3      **Design of Mixtures:**

1006-3.01      **Design Criteria:**

Portland cement concrete shall conform to the requirements specified in Table 1006-A for each of the classes listed therein.

TABLE 1006-A				
Class of Concrete	Minimum 28-Day Compressive Strength Required: psi (See Note 1)	Hydraulic Cement Content: Lbs per Cu Yd Minimum-Maximum (See Notes 2, 3, & 4)	Maximum Water/Cement Ratio	Slump Range: Inches
B	2,500	470 – 658	None	(See Note 6)
S or E	2,500	520 – 752	0.55	
	3,000 (See Note 5)			
	3,500			
	4,000			
	4,500 and greater	564 – 752	0.50	
P	4,000	564 – 658	None	0 – 4.5
H	High performance concrete as specified in project special provisions.			



**TABLE 1006-A (continued)**

Note 1: Testing for compressive strength of cylinders for all classes of concrete shall be in accordance with the requirements of Arizona Test Method 314.

Note 2: A supplementary cementitious material (fly ash, natural pozzolan, or silica fume) conforming to the requirements of Subsection 1006-2.04(D) may be used at the option of the contractor only when Portland cement is used. The use of a supplementary cementitious material is not allowed for replacement of cement when Portland-pozzolan cement [Type IP (MS)] is used. A maximum of 25 percent of the required weight of Portland cement may be replaced with fly ash or natural pozzolan. A maximum of 10 percent of the required weight of Portland cement may be replaced with silica fume, or a maximum of 10 percent silica fume may be added to the required weight of Portland cement. When supplementary cementitious material is used as a replacement for Portland cement, the replacement shall be made on a 1.0 pound to 1.0 pound basis. If performance enhancement of the concrete, such as the mitigation of an alkali silica reaction or for increased sulfate resistance is necessary, additional quantities of fly ash or natural pozzolan may be incorporated into the concrete without a corresponding Portland cement replacement, if approved by the Engineer.

Note 3: The hydraulic cement content shall be as shown unless otherwise specified.

Note 4: Concrete to be placed under water, tremie concrete, shall conform to the requirements for the class and strength required except the minimum hydraulic cement content shall be increased by 50 pounds per cubic yard of concrete.

Note 5: Unless otherwise shown on the plans.

Note 6: The proposed slump shall be chosen by the contractor. Concrete at the proposed slump shall be sufficiently workable to allow proper placement without harmful segregation, bleeding, or incomplete consolidation.

Air-entraining admixtures will be required for all classes of concrete placed at an elevation of 3,000 feet or above. The amount of entrained air in the concrete mixture shall not be less than four percent nor more than seven percent by volume. However, 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 will be required for any precast items constructed using the dry pack or no-slump method.

For elevations below 3,000 feet, air-entraining admixtures may be used at the option of the contractor. If air-entraining admixtures are used, the amount of entrained air in the concrete shall not exceed seven percent by volume.

Concrete that fails to conform to the entrained air content requirements listed above for the respective elevation as determined by the Engineer, shall be rejected prior to placement.

Unless specifically required, water-reducing admixtures may be used at the option of the contractor.

The coarse aggregate size designation for Class S, Class B, and Class E 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 one fifth of the narrowest dimension between sides of adjacent forms, or two thirds of the minimum clear spacing between reinforcing bars, or one third 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. The percent of fractured coarse aggregate particles shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

Coarse aggregate for Class P concrete used to construct Portland cement concrete pavement without load transfer dowels shall be separated into two 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. The percent of fractured coarse aggregate particles for this coarse aggregate composite shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

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. The percent of fractured coarse aggregate particles shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

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.

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### **1006-3.02      Design Procedures:**

At least two weeks prior to the appropriate concreting operation, the contractor shall furnish a mix design for each class of concrete and each strength of Class S and Class E concrete for review and approval. More than one mix design for each class of concrete and each strength of Class S and Class E concrete may be submitted for approval provided specific items and locations of intended uses accompany the mix design. The contractor shall substantiate each mix design by furnishing test data and providing all details of the mixtures proposed for use. The mix design shall be prepared under the direct supervision of, and signed by, a registered professional engineer, a NICET Level III or higher certified technician in the concrete subfield, or an ACI certified Concrete Laboratory Testing Technician Grade II. Individuals preparing and submitting mix designs shall have experience in the development of mix designs and mix design testing.

The complete solid volume mix designs submitted for approval shall include all weights and volumes of all ingredients. The brand, type, and source of hydraulic cement and admixtures, the coarse aggregate size number designation, source of aggregates, the specific gravities of all ingredients, the proposed slump, the water/cement ratio, a product code to identify the mix design, and the intended use of each mix design shall be an integral part of each mix design.

The use of new and previously used mix designs, and the requirements for trial batches, will be as required by the Materials Policy and Procedure Directive "Submittal and Approval of Portland Cement Concrete Mix Designs".

Changes in approved mix designs may be made by the contractor with the approval of the Engineer.

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 new mix design shall be submitted for approval any time the test results of an approved mix design indicate that the concrete does not meet the required compressive strength.

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 will meet the requirements of the class of concrete at that location. The basis of payment for such concrete shall be that which applies to the concrete required 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 and Class E concrete from a source approved by the Engineer in lieu of establishing a batch plant at the project site.

For each class of concrete and each strength of Class S and Class E concrete, except for Class P concrete produced in a batch plant at the site and used exclusively for Class P work, the contractor shall furnish a delivery ticket for each batch of concrete. The minimum information to be shown on each delivery ticket shall be the date, time batched, truck identification number, name or identification of batch plant, name of contractor, name and location of project, the quantity of concrete, the batch weights or mix design product code, the amount of permissible additional water to meet the design water/cement ratio, and the number of revolutions that the concrete has been mixed at mixing speed in a truck mixer. 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 immediately furnish the delivery ticket to the Engineer.

#### **1006-4.02      Proportioning:**

##### **(A)      Hydraulic Cement:**

A separate scale shall be used to weigh the hydraulic cement. A load indicating device, positioned so as to be easily visible to the Engineer and accurate to  $\pm 0.2$  percent of scale capacity, shall be provided to weigh all hydraulic cement. The batching accuracy shall be within  $\pm 1.0$  percent of the required weight. Load-indicating devices for the scale, or a load cell providing a digital printed readout will be required when weighing all hydraulic cement.

The cement shall be conveyed by means of an enclosed conveying system and the weighing hopper shall be equipped with one or more vibrators as required to ensure the complete discharge of all cement from the hopper after each batch is weighed.

##### **(B)      Water:**

Water shall be measured by volume or by weight. Measurement by volume will be by metering.

Scales shall be accurate within  $\pm 0.2$  percent of scale capacity. Volumetric measuring devices shall have an accuracy of  $\pm 1.5$  percent. The batching devices shall be capable of routinely batching water within  $\pm 1.5$  percent.

##### **(C)      Aggregates:**

All aggregates shall be proportioned by weight.

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Suitable scales shall be provided by the contractor to weigh each size of aggregate. Load indicating devices for the scales shall be positioned so as to be easily visible to the Engineer and accurate to  $\pm 0.2$  percent of scale capacity. The batching accuracy shall be within  $\pm$  two percent of the target weight. The weighing equipment shall be arranged so as to permit the convenient removal of excess material from the weighing hopper and the equipment shall be arranged to enable the operator to have convenient access to all controls. The scales and load indicating devices shall be so graduated and equipped that the weights of materials can be accurately determined. Necessary efforts shall be made to obtain and preserve uniform moisture content in the coarse and fine aggregates. The moisture content shall not vary more than three percent during any day's concrete production. The estimated percent of free moisture in each of the coarse and fine aggregates shall be determined by the contractor using acceptable test methods.

The moisture content of the aggregate shall be such that no free drainage of water from the aggregate will be visible during transportation from the stockpile to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until it is sufficiently dry to meet the above requirement.

In the event that either the coarse or fine aggregate has a moisture absorption rate of more than 1.5 percent, the materials shall be thoroughly prewetted and allowed to drain in advance of use until the moisture content is stable.

### **(D)     Admixtures:**

The equipment and the procedures used to measure admixtures and dispense them into the concrete batch shall be approved by the Engineer prior to use.

Dry admixtures shall be measured by weight with a separate scale. A load indicating device for the scale shall be positioned so as to be easily visible to the Engineer and accurate to within  $\pm 1.0$  percent of the amount being weighed. Paste or liquid admixtures shall be measured either by weight or by volume. Only mechanical dispensing equipment shall be used for adding admixtures. Dosage rates shall conform to the manufacturer's recommendations or approved rates, or as determined from field trial batches.

Dispensers for admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Admixtures shall be added in accordance with the manufacturer's recommendations and in a manner such that the admixture is incorporated uniformly in the concrete mixture. The amount of liquid admixtures shall not vary from the required amount by more than  $\pm 3.0$  percent.

Equipment for measurement shall be designed for convenient confirmation of measurement accuracy. If more than one liquid

admixture is used, each admixture shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

When a supplementary cementitious material (such as fly ash, natural pozzolan, or silica fume) is specified in the mix design, it may be weighed cumulatively with the hydraulic cement on the same scale. If the same scale is used, the hydraulic cement shall be weighed first, then the supplementary cementitious material. If the same scale is not used, a separate scale with a load-indicating device, positioned so as to be easily visible to the Engineer and accurate to  $\pm 0.2$  percent of scale capacity, shall be provided to weigh the supplementary cementitious material.

When the quantity of hydraulic cement exceeds 30 percent of the full capacity of the scale, the batching accuracy of mixtures containing supplementary cementitious material shall be such that the quantity of the hydraulic cement, and the cumulative quantity of the hydraulic cement plus the supplementary cementitious material, is within  $\pm 1.0$  percent of the sum of their designated batch weights.

Supplementary cementitious material shall be conveyed by means of an enclosed conveying system, and the weighing hopper shall be equipped with one or more vibrators as required to ensure the complete discharge of the supplementary cementitious material from the hopper after each batch is weighed.

#### **1006-4.03      Mixing:**

##### **(A)      General Requirements:**

The concrete may be mixed in a stationary mixer, either at a central mixing plant or at the site, or it may be mixed in a truck mixer, either at a central mixing plant or at the site. Concrete may be mixed in a mobile mixer at the site for Class S, Class B, and Class E concrete, provided written permission of the Engineer is granted.

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.

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 from the time hydraulic cement is combined with water.

Mixers shall be cleaned at suitable intervals. Water used for cleaning the mixer shall be discharged prior to further batching.

Equipment having components made of aluminum or magnesium alloys, which would have contact with plastic concrete during mixing and transporting, shall not be used.

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All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of un-dispersed cement.

### **(B) Mixing in a Stationary Mixer:**

The volume of concrete mixed per batch shall not exceed the capacity of the mixer as shown on the manufacturer's plate. No spillage of concrete will be 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 on 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 one cubic yard and shall be increased 15 seconds for each additional cubic yard or fraction thereof for Class S, Class B, and Class E concrete.

The mixers 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.

Stationary 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.

Mixed concrete shall be transported in truck mixers, truck agitators or in non-agitating trucks having special bodies.

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.

Discharge from the truck mixer or truck agitator shall be completed within 90 minutes from the time batched, unless otherwise noted in the mix design and approved by the Engineer.

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 will be exposed to the sun for more than 30 minutes.

**(C) Mixing in Truck Mixers:**

Truck-mixed concrete shall be mixed entirely in the truck mixer and shall be mixed at the batch plant or at the site.

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.

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, 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. Mixing shall begin within 10 minutes after the cement has been combined with either the aggregate or water.

The truck mixer 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 just inside the truck cab, so that it may be safely and conveniently read from beside the truck. The revolution counter shall be reset to zero after all materials have been loaded into the drum.

Discharge from the truck mixer shall be completed within 90 minutes from the time batched, unless otherwise noted in the mix design and approved by the Engineer.

If additional mixing water is required to maintain the mix design water/cement ratio, 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. Any additional mixing water and required mixing revolutions shall be recorded on the delivery ticket specified in Subsection 1006-4.01. This additional mixing may be in excess of the maximum revolutions previously specified.



**(D) Mixing in Mobile Mixers:**

Concrete mixing in mobile mixers for Class S, Class B, and Class E concrete shall be performed in accordance with the requirements of AASHTO M 241.

**1006-4.04 Consistency:**

The contractor shall furnish Class P Concrete having a slump within the range specified in Table 1006-A.

The contractor shall furnish Class S, Class B, and Class E concrete having the slump shown on the approved mix designs with a permissible variation of  $\pm$  one inch; however, the permissible variation will be  $\pm$  two inches when an approved high range water reducing chemical admixture (ASTM C 494, Type F or Type G) conforming to the requirements of Subsection 1006-2.04 is used.

Concrete that fails to conform to the consistency requirements will be rejected.

When concrete is pumped, samples for consistency will be taken both as the concrete leaves the mixer and at the pump hose discharge. If the Engineer determines that there is a good correlation between the results of consistency tests on samples obtained from the mixer and from the pump hose, the Engineer may discontinue sampling from one of the sources; however, the Engineer may take periodic samples from both sources to verify the correlation of test results.

**1006-5 Weather Limitations:**

**1006-5.01 General Requirements:**

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, Class B, and Class E concrete.

**1006-5.02 Hot Weather Concreting:**

The temperature of the concrete mixture immediately before placement shall not exceed 90 degrees F.

Forms, subgrade and reinforcing steel, shall be sprinkled with cool water just prior to placement of concrete.

Mix water may be cooled by refrigeration, liquid nitrogen, or well-crushed ice of a size that will melt completely during the mixing operation. Crushed ice may be substituted for part of the mix water on a pound for pound basis.

#### **1006-5.03 Cold Weather Concreting:**

The temperature of the mixed concrete immediately before placing shall not be less than 50 degrees F.

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.

Concrete operations shall be discontinued when a descending air temperature in the shade and away from artificial heat falls below 40 degrees F nor shall concrete operations be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35 degrees F unless otherwise approved by the Engineer.

Mixing and placing concrete shall continue no later in any day than that time which will allow sufficient time to place and protect the concrete already poured before the air temperature drops to 35 degrees F.

Concrete operations may be allowed although the air temperature at any time during the cure period in the shade and away from artificial heat is below the limit permitted above. Where concrete operations are thus allowed, the contractor shall use equipment to heat the aggregates or water, or both, prior to mixing. If aggregates are heated, the minimum temperature 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.

When concreting operations are allowed when the air temperature falls below the limits permitted in the shade and away from artificial heat, the contractor shall provide adequate insulation or heat, or both, to protect the concrete after placement. This protection shall be to the extent required to maintain a concrete surface temperature of 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. When artificial heating is required, the heating units shall not locally heat or dry the surface of the concrete. A written outline of the proposed protection method shall be submitted to the Engineer for approval.

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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 period in a manner that will permit a gradual drop in the concrete temperature.

### **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.

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:**

All surfaces not covered by reasonably 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 not less than one gallon per 100 square feet.

The curing compound shall form a continuous unbroken surface.

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 assure 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. Liquid-membrane forming compound shall be applied at a rate of one gallon per 100 square feet. The curing compound shall form a continuous unbroken surface.

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.

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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 if it elects, 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.

#### **(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.

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. 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 will be required for checking temperature.

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 two  $\pm 1/2$  inches from the heated form.

### **1006-7 Acceptance Sampling and Testing**

#### **1006-7.01 General:**

Rejection of concrete will occur due to improper temperature, slump, and/or air content for the concrete mixture delivered to the site. The Engineer may allow failed concrete mixture already placed to remain in place subject to acceptance by compressive strength or may require its removal.

Rejection of concrete will also occur due to insufficient compressive strength. Concrete compressive strength requirements consists of the specified strength which the concrete shall attain before various loads or stresses are applied and a minimum strength at 28 days.

Acceptance and penalties for placed concrete which meets the above mixture requirements or is allowed to remain in place shall be determined by the results of the 28-day compressive strength, and additionally in the case of Class P concrete, on the measured thickness of concrete pavement in place according to Section 401. 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 or Class E concrete.

#### **1006-7.02 Sampling and Testing of Concrete:**

A sample of concrete for determination of temperature, slump, 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.

Samples of concrete shall be of sufficient size to perform all the required tests and fabricate the necessary test cylinders. The samples shall be taken in accordance with the requirements of AASHTO T 141, except as follows:

- (1) Concrete for Class S, Class B, or Class E shall be sampled only once during discharge in the middle portion of the batch. At the discretion of the Engineer, a sample may be obtained at the beginning of the discharge if, in the Engineer's opinion, the properties of the concrete do not appear to be within the specification limits for slump or temperature.
- (2) Concrete for Class P shall be sampled immediately before going into the paver or forms, or as otherwise directed by the Engineer.

If concrete is pumped to facilitate placement, at the discretion of the Engineer, samples may be taken from the truck and pump hose discharge to determine that the compressive strength specifications are met in the structure, and to correlate temperature, slump and air content results. If the correlation is satisfactory and meets with the approval of the Engineer, sampling may continue from the most convenient location with occasional re-testing for correlation. Rejection of concrete due to improper temperature or slump may occur at either the truck or pump hose discharge; however, rejection of concrete due to improper air content will only occur due to a failing test for a sample obtained at the final point of discharge.

Temperature of the concrete mixture will be determined in accordance with ASTM C 1064. Slump of the concrete mixture will be determined in accordance with AASHTO T 119. Air content of the concrete mixture will be determined in accordance with AASHTO T 152. All compressive strength test cylinders will be made, cured, handled, protected, and transported in accordance with the requirements of AASHTO T 23. Testing for compressive strength of cylinders shall be in accordance with the requirements of Arizona Test Method 314.

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 fabricated as specified in Subsection 1006-7.03. 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 test cylinders differ by more than 10 percent from the average of the three, the results of both will be discarded and the compressive strength shall be the strength of the remaining cylinder.

### **1006-7.03      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 psi, or Class B concrete, a sample of concrete for the required tests, as specified in Subsection 1006-7.02, 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 psi, a sample of concrete for the required tests, as specified in Subsection 1006-7.02, 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 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 E Concrete:**



Class E concrete shall be sampled and tested for compressive strength by the sub-lot. A sub-lot will be 30 cubic yards or an accumulation of quantities of a specified strength of concrete to total 30 cubic yards. A sample will be obtained for each portion of concrete between 10 and 30 cubic yards, inclusive, for each specified strength of concrete. For each specified concrete strength, the quantity of concrete represented by four samples will be defined as a lot. However, for a continuous pour of greater than 120 cubic yards of a specified strength of concrete, the total amount of concrete in that pour will be considered to be a lot, and four samples will be taken at randomly selected locations as directed by the Engineer. The Engineer may exclude certain locations from random sampling should the Engineer determine 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.

Class E concrete shall be sampled and tested for temperature and slump for each 30 cubic yards. For concrete placed at an elevation of 3,000 feet or above, a sample will be taken for each 30 cubic yards for testing of air content. For quantities of concrete less than 30 cubic yards, the sampling and testing frequency for temperature, slump, and air content may be reduced with the concurrence of the Engineer. Additional samples for any of the required tests may be taken at the discretion of the Engineer.

**(C) 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 should the Engineer determine 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.

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 concurrence of the Engineer. Additional samples for any of the required tests may be taken at the discretion of the Engineer.

**1006-7.04 Sampling Frequency for Precast Concrete:**

A sample of concrete for the required tests as specified in Subsection 1006-7.02 will be taken for either each precast concrete

member or for each day's production at the discretion of the Engineer, when the method of measurement is by the unit.

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.

#### **1006-7.05      Testing for 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 C 805.

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. The test cylinders will be fabricated in accordance with the requirements of AASHTO T 23. Testing for compressive strength of cylinders shall be in accordance with the requirements of Arizona Test Method 314.

#### **1006-7.06      Acceptance for Compressive Strength:**

##### **(A)      Class P Concrete:**

Class P concrete will be accepted for compressive strength in accordance with the provisions of Section 401. All concrete failing to meet the compressive strength requirement or otherwise rejected in accordance with Section 401 or Subsection 1006-7.01, 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 Arizona Test Method 317. 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. The contractor may elect to have a representative present during

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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.

(B) 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 One Percent	Percent Reduction in Contract Unit Price (See Note 1)	Percent of Specified 28-Day Compressive Strength Attained, to the Nearest One Percent	Percent Reduction in Contract Unit Price (See Note 1)	Percent of Specified 28-Day Compressive Strength Attained, to the Nearest One 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)
Note 1: For items measured and paid for by the cubic yard, the reduction shall not exceed \$150.00 per cubic yard.					
Note 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, will be rejected and removed in accordance with the provisions of Subsection 106.11 at no additional cost to the Department, 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 Arizona Test Method 317. 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.

### **(C) Class E Concrete:**

Class E concrete will be accepted for compressive strength in accordance with the provisions of Section 611. All concrete failing to meet the compressive strength requirement or otherwise rejected in accordance with Section 611 or Subsection 1006-7.01, 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 deficiency in compressive strength, 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 Arizona Test Method 317. 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. 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

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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.

### **1006-8 Method of Measurement and Basis of Payment:**

The method of measurement and basis of payment will be made as specified herein and under the provisions specified in the various sections of the specifications covering construction requiring the use of concrete.

## **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 ASTM D 4956-04 for the applicable type and class, unless otherwise specified. All references herein to ASTM D 4956 shall refer to ASTM D 4956-04.

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 PRIDE program.

A Certificate of Compliance, conforming to the requirements of Subsection 106.05, 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:**

The type of sheeting to be used in any given application will be called out on the project plans. Type VI is a flexible sheeting material suitable for use with roll-up signs. For applications where more than

one sheeting type is allowed, the contractor may use a higher grade of sheeting than specified at no additional cost to the Department.

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 warning signs with yellow backgrounds shall use fluorescent yellow sheeting.

All work zone signs with orange backgrounds shall use fluorescent retroreflective orange sheeting, except that non-reflective sign materials may be used for temporary work zone signs where the signs will be clearly visible under available natural light.

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 D 4956.

In addition to the luminance and color requirements, fluorescent orange sheeting shall have the capacity to effectively fluoresce outdoors under low light conditions. For all applications requiring fluorescent orange 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 D 4956 for the type of retroreflective sheeting specified.

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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 either Class I or II as specified in ASTM D 4956 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.

Heat-activated adhesives shall allow positioning under normal working conditions and temperatures without damage to the materials or application surface. This type of adhesive shall be activated by applying heat in excess of 150 degrees F to the material using a heat vacuum process. No pre-treatment of the heat activated adhesive shall be necessary.

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. 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.

Type IV, VIII, IX, X, and XI sheeting shall be weather-tested, as specified above, for a period of 60 months. Orange colored sheeting used for construction zone signing, barricades, and channeling devices shall be weather-tested for a period of 18 months. All other sheeting shall be weather-tested for a period of 30 months. 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.

Type IV, VIII, IX, X, and XI sheeting, related inks and films shall have a minimum ten year durability rating. All orange sign sheeting shall have a minimum durability rating of three years. All other sheeting, films, and inks shall have a minimum durability rating of five years.

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:

- (1) Bubbles, wrinkles, cracks or breaks on any portion of the applied materials greater than three inches in length that result in a negative appearance or concerns of additional degradation.
- (2) Significant shrinkage that causes the material to curl or to pull away from the background.
- (3) 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).
- (4) Significant visible discoloration, including clouding or chalking.
- (5) A loss of transparency of any transparent sheeting, ink or film.
- (6) A loss in opaqueness of any opaque ink or film.



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- (7) Significant cracking, blistering, ripping, flaking, curling or chipping of any sheeting, ink or film.
- (8) 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.

### **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. The certificate shall state that the reflectors comply in all respects with the following requirements:

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 effect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

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 five 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:

- Submerge five retroreflectors in a water bath at room temperature. Subject the submerged units to a vacuum of five inches gauge (water) for five minutes, then examine them for water intake. Failure of one or more units shall constitute failure of the lot.

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- Three reflectors shall be tested for four hours in a circulating air oven at 175 ± five 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.
- The assembled cut-out letter, symbol, or accessory shall withstand the combined corrosion test set forth in ASTM B 117. 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.  Colorless
		*White	Yellow	Green	Red	
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
* 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.

**(B) Crumb Rubber:**

Crumb rubber shall meet the following gradation requirements when tested in accordance with Arizona Test Method 714.

<b>TABLE 1009-1</b>		
<b>Sieve Size</b>	<b>Percent Passing</b>	
	<b>Type A</b>	<b>Type B</b>
No. 8	100	
No. 10	95 - 100	100
No. 16	0 - 10	65 - 100
No. 30		20 - 100
No. 50		0 - 45
No. 200		0 - 5

The crumb rubber shall have a specific gravity of  $1.15 \pm 0.05$  and shall be free of wire or other contaminating materials, except that Type A crumb rubber shall contain not more than 0.1 percent fabric and Type B crumb rubber shall contain not more than 0.5 percent fabric. Calcium carbonate, up to four 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 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.

**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	PG 64-16	PG 58-22	PG 52-28
Rotational Viscosity*: 350 °F; Pascal·seconds	1.5 - 4.0	1.5 - 4.0	1.5 - 4.0
Penetration: 39.2 °F, 200 g, 60 sec. (ASTM D 5); 0.1 mm, minimum	10	15	25
Softening Point: (ASTM D 36); °C, minimum	57	54	52
Resilience: 77 °F (ASTM D 5329); %, minimum	25	20	15
<p>* The viscotester used must be correlated to a Rion (formerly Haake) Model VT-04 viscotester using the No. 1 Rotor. The Rion viscotester rotor, while in the off position, shall be completely immersed in the binder at a temperature from 350 to 355 degrees F for a minimum heat equilibrium period of 60 seconds, and the average viscosity determined from three separate constant readings (<math>\pm 0.5</math> Pascal·seconds) taken within a 30 second time frame with the viscotester level during testing and turned off between readings. Continuous rotation of the rotor may cause thinning of the material immediately in contact with the rotor, resulting in erroneous results.</p>			

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 ADJUSTMENT 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	100	≥ 15	100	≥ 25	100
	8-9	85	13-14	85	23-24	85
	< 8	70*	< 13	70*	< 23	70*
Softening Point	≥ 57	100	≥ 54	100	≥ 52	100
	55-56	85	52-53	85	50-51	85
	< 55	70*	< 52	70*	< 50	70*
Resilience	≥ 25	100	≥ 20	100	≥ 15	100
	20-24	85	15-19	85	10-14	85
	15-19	70	10-14	70	6-9	70
	< 15	50*	< 10	50*	< 6	50*

\*Reject Status: The pay adjustment applies if allowed to remain in place.

Should the asphalt-rubber 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.

#### **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.

#### **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 350 and 400 degrees F at the time of addition of the crumb rubber. No agglomerations of crumb rubber particles in excess of two inches shall

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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% 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 325 and 375 degrees F. The contractor shall ensure that the crumb rubber and asphalt cement are thoroughly mixed prior to the beginning of the reaction period. The reaction period shall be a minimum of one-hour, during which time the asphalt-rubber is continued to be mixed while a temperature between 325 and 375 degrees F is maintained. 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.

Prior to use, the viscosity of the asphalt-rubber shall be tested by the use of a rotational viscotester, which is to be furnished by the contractor or supplier.

### **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 325 and 375 degrees F.

If in the first ten hours after the completion of the reaction period the temperature of the asphalt-rubber drops below 325 degrees F, it may be reheated to a temperature between 325 and 375 degrees F.

In no case shall the asphalt-rubber be held at a temperature between 325 to 375 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 325 and 375 degrees F before use.

The reheating of asphalt-rubber that has cooled below 325 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:

- (1) The source, grade, amount and temperature of the asphalt cement prior to the addition of crumb rubber.

- (2) The source and amount of crumb rubber and the crumb rubber content expressed as percent by the weight of the asphalt cement.
- (3) Times and dates of the crumb rubber additions and resultant viscosity test.
- (4) 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.

## **SECTION 1010 DRAINAGE PIPE:**

### **1010-1 General Requirements:**

Certificates of Compliance shall be furnished in accordance with the requirements of Subsection 106.05.

### **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



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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 F 568.

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 A 153 or coated by the electroplating process in accordance with the requirements of ASTM B 633 or ASTM B 766. Components of bolted assemblies shall be galvanized in accordance with ASTM A 153 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 seven inches wide and one half inch thick. Rubber for the gaskets shall conform to the requirements of ASTM D 1056 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 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 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, 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 three-inch by three-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:

<b>SPIRAL RIB METALLIC COATED STEEL PIPE</b>		
<b>Pipe Diameter, Inches</b>	<b>Minimum Thickness, gage</b>	<b>Corrugation Rib Size, Inches</b>
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

<b>SPIRAL RIB ALUMINUM PIPE</b>		
<b>Pipe Diameter, Inches</b>	<b>Minimum Thickness, Gage</b>	<b>Corrugation Rib Size, Inches</b>
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:

<b>Pipe Diameter, Inches</b>	<b>Minimum Thickness, Inches (Gage)</b>	<b>Corrugation Rib Size, Inches</b>
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 (2) 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 C 361 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.

**(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

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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 fifteen (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 A 36 or A 576 and shall be galvanized in accordance with the requirements of ASTM A 123. 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 F 568 and shall be galvanized in accordance with the requirements of ASTM A 123.

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 one inch strips or in one inch diameter beads on one 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.

Materials used for grout shall conform to the requirements of Section 1006. The grout shall be composed by volume of one part Portland cement, three parts fine aggregate and one-fifth part hydrated lime. Hydrated lime shall conform to the requirements of ASTM C 207, Type N. To these mixed materials sufficient water shall be added to provide a mixture that will flow readily. Grout that has been mixed more than one hour shall not be used. Retempering 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 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, 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.

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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.

Gaskets for reinforced concrete pipe (circular) joints shall conform to the requirements of AASHTO M 198.

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.

Fine aggregate shall conform to the grading requirements of ASTM C 144. Hydrated lime shall conform to the requirements of ASTM C 207, 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.

### **1010-8                    Corrugated High Density Polyethylene 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 48 inches in diameter.

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 D 3212, 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 D 3212.

Magnetic tape, which is to be placed in the trench with the corrugated high density polyethylene plastic pipe as an aid in location after burial, shall have a minimum overall thickness of 5.5 mils and a minimum tensile strength of 5,000 pounds per square inch.

#### **1010-9            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 A 307 and shall be galvanized in accordance with the requirements of ASTM A 153.

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 A 123. Components of bolted assemblies shall be galvanized after fabrication in accordance with the requirements of ASTM A 153 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  $\pm 1/8$  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.



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Certificates of Compliance conforming to the requirements of Subsection 106.05 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 D 412), psi	Minimum 3,500
Elongation at Breaking (ASTM D 412), 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 D 2240)	55 to 65
Tensile Strength and Elongation at Breaking (ASTM D 572), 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 D 412), psi	Minimum 2,500
Elongation at Breaking (ASTM D 412), percent	Minimum 425
Shore Durometer (Hardness) (ASTM D 2240)	50 to 70
Tensile Strength and Elongation at Breaking (ASTM D 572), 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 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-Poured):**

Joint sealant material shall be a one component, hot poured type, conforming to the requirements of either ASTM D 3406 or ASTM D 3569. Joint sealant shall not contain any coal-tar materials.

The following requirement shall be added to paragraphs 7.1 of ASTM D 3406 and 7.1 of ASTM D 3569:

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 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 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 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 D 3542.

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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 three 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 D 4070.

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 D 4070.

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 D 3542 modified as follows:

- (a) Recovery testing is excluded.
- (b) TABLE 1 of ASTM D 3542 is revised as follows:

**TABLE NO. 1**  
**PHYSICAL PROPERTIES FOR PREFORMED ELASTOMER STRIP**  
**SEALS**

Property	Requirement	ASTM Test Method
Tensile strength, minimum psi	2000	D 412
Elongation at break, min. %	250	D 412
Hardness, Type A durometer, points	60 ± 5	D 2240 (Modified) (1, 3)
Oven aging, 70 hr at 212 °F		D 573
Tensile strength, loss, max. %	20	
Elongation, loss, max. %	20	
Hardness, Type A durometer, points change	0 to + 10	D 2240 (Modified) (1, 3)
Oil swell, ASTM Oil No. 3, 70 hr at 212 °F, weight change, max. %	45	D 471
Ozone resistance, 20 % strain, 300 pphm in air, 70 hr at 104 °F	No Cracks	D 1149 (Modified) (2)
Low temperature stiffening 7 days at 14 °F; Hardness, Type A durometer, points change	0 to +15	D 2240 (Modified) (1, 3)
Compression set, 70 hr at 212 °F, maximum %	40	D 395 Method B (Modified) (1)
(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 D 518 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 D 2240.		

#### **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 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.

**1011-7 Cellular Plastic Joint Filler:**

Cellular plastic joint filler shall conform to the requirements of ASTM D 3204. 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 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 D 5893, 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 of less than one percent total failure

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(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 PRIDE program. In addition, a Certificate of Analysis conforming to the requirements of Subsection 106.05 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 shall be submitted.

References to ARTBA in this section shall hereinafter refer to AASHTO-AGC-ARTBA "A GUIDE TO STANDARDIZED HIGHWAY BARRIER HARDWARE", 1995 edition.

### **1012-2 Fasteners, Elements, Posts and Blocks:**

Guardrail fasteners, posts, blocks, and other components shall conform to the requirements of ARTBA.

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 Miscellaneous Materials:**

Nails shall be 16-penny common, galvanized. Nails for retainer strap shall be 10-penny common, galvanized.

The metal used to manufacture reflector tabs shall be either 3003-H14 aluminum strip  $0.063 \pm 0.004$  inches thick, or steel strip  $0.078 \pm 0.008$  inches thick galvanized in accordance with ASTM A 653 coating designation G 90. The reflector material shall be high-reflectivity sheeting, either silver-white or yellow and shall conform to the requirements of Section 1007. Adhesive for sheeting attachment to the metal tab shall be of the type and quality recommended by the sheeting manufacturer.

Nuts, bolts, and washers to be used in installations for which the details are not shown on the plans nor in the ARTBA publication shall conform to the requirements of ASTM F 568 or A 307; be galvanized in

accordance with the requirements of ASTM A 153, 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 A 36 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 A 500 or A 501 and shall be galvanized in accordance with the requirements of AASHTO M 180, Type 1.

The tubular thrie beam shall be fabricated from thrie beam elements conforming to the requirements of ARTBA.

Where galvanizing has been damaged, the coating shall be repaired by painting with two coats of zinc paint, in accordance with Section 1002.

#### **1012-4 Timber Guardrail, Posts and Blocks:**

Timber for posts and blocks shall be rough sawn (unplaned) or S4S with the nominal dimensions indicated. Any species or group of woods graded in accordance with the requirements for Timber and Posts of the Western Wood Products Association may be used.

Timber shall be No. 1 or better, and the stress grade shall be as follows:

6 inch by 8 inch Post and Block	1,200 psi
8 inch by 8 inch Post and Block	900 psi
10 inch by 10 inch Post and Block	900 psi

When the plans show guardrail systems using eight-inch by eight-inch timber posts and blocks, the contractor may use 8-1/4 inch by 8-1/4 inch nominal size posts and blocks with a stress grade of 825 pounds per square inch.

At the time of installation, the dimensions of timber posts and blocks shall vary no more than  $\pm 1/2$  inch from the nominal dimensions as hereinbefore specified.

The size tolerance of rough sawn blocks in the direction of the bolt holes shall vary no more than  $\pm 3/8$  inch. Only one type of post and block shall be used for any one continuous length of guardrail.

All timber shall have a preservative treatment in accordance with the requirements of AASHTO M 133.



**SECTION 1013 BEARING PADS:**

**1013-1            Preformed Fabric Pads:**

Preformed fabric pads shall be composed of multiple layers of eight-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.

**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), and shall be subjected to the load testing requirements corresponding to Method A design.

#### **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  $73 \pm 4$  degrees F, unless otherwise noted. Shear modulus tests shall be carried out using the apparatus and procedures described in Annex A1 of ASTM D 4014.

**Table 1013-1**  
**ELASTOMERIC COMPOUND REQUIREMENTS**

Note that ASTM D 1043 refers to "modulus of rigidity" while ASTM D 4014 refers to "shear modulus." The word "stiffness" is used here to cover both terms.

**Physical Properties**

D 2240	Hardness: Shore A Durometer	45 to 75		
		50 $\pm$ 5	60 $\pm$ 5	70 $\pm$ 5
D 412	Ultimate Elongation: min. %	400	350	300
	Tensile Strength: min. psi	2250		

**Heat Resistance**

D 573: 70 hrs at 212 °F	Change in Durometer Hardness: maximum points	15		
	Change in Tensile Strength: maximum %	- 15		
	Change in Ultimate Elongation: maximum %	- 40		

**Compression Set**

D 395, Method B	22 hr at 212 °F: maximum %	35		
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**Ozone**

D 1149	100 pphm ozone in air by vol., 20 % strain, 100 $\pm$ 2 °F, 100 hr, mounting IAW ASTM D 518 (Procedure A)	No Cracks		
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**Low Temperature Brittleness**

D 746 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**

D 1043	Grade 0: Tested at - 25 °F	(1)		
	Grade 2: Tested at - 25 °F	(1)		
	Grade 3: Tested at - 40 °F	(1)		

**Low Temperature Crystallization**

Quad Shear Test As Described	Grade 0: No Test Required	(2)		
	Grade 2: 7 Days at 0 °F	(2)		
	Grade 3: 14 Days at - 15 °F	(2)		

- (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  $\pm$  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.

Certification, sampling and testing shall conform to the requirements of Subsection 1013-3.

**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. The stacking of individual laminated pads to attain thicknesses over 1/2 inch will not be permitted; however, cold bonding of individual laminated pads will be permitted providing the bond between the pads has a minimum peel strength of 20 pounds per inch of width.

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 not vary.

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.

**1013-2.04 Steel Reinforced Elastomeric Bearing Pads:**

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.

Steel-reinforced elastomeric bearing pads shall conform to the requirements for steel-laminated elastomeric bearings as specified in ASTM D 4014 and the following:

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 14 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.

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.

Steel laminates used for reinforcement shall be made from rolled mild steel conforming to ASTM A 36, ASTM A 1011, or ASTM A 1008, 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.

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.

Steel laminated bearings shall develop a minimum peel strength of 40 pounds per inch of width.

**1013-2.05 Fabrication Tolerances:**

Plain pads and laminated bearings shall be built to the specified dimension within the tolerances listed in Table 1013-2.

<b>Table 1013-2 FABRICATION TOLERANCES</b>		
<b>Parameters</b>	<b>Tolerances</b>	
	<b>Minus</b>	<b>Plus</b>
1. Overall Height: Design Thickness 1-1/4 inch or less Design Thickness over 1-1/4 inch	-0 -0	+1/8 inch +1/4 inch
2. Overall Horizontal Dimensions: 36 inches or Less Over 36 inches	-0 -0	+1/4 inch +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 Sides	0.005 Radians 0.02 Radians	
5. Position of Exposed Connection Members, Holes, Slots, or Inserts	± 1/8 inch	
6. Edge Cover: Embedded Laminates or Connection Members	-0	+1/8 inch
7. Thickness: Top and Bottom Cover Layer (if required)	-0	smaller of +1/16 inch and +20% of the nominal cover layer thickness
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).

**(B) Testing by Manufacturer:**

The contractor shall furnish the Engineer with Certificates of Analysis, conforming to the requirements of Subsection 106.05, from the manufacturer certifying that the bearings to be furnished conform to all specified requirements.

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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.

The ambient temperature tests on the elastomer described in Subsection 1013-3.02(A) 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. Certificates of Analysis from the manufacturer shall be provided for each lot of reinforcement.

All three low temperature tests described in Subsection 1013-3.02(C) 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.

Instantaneous thermal stiffening tests shall be conducted on material of Grades 0 and 2. Low temperature brittleness and crystallization tests are not required for Grade 0 or 2 materials.

Every finished bearing shall be visually inspected in accordance with Subsection 1013-3.02(D).

Every steel reinforced bearing shall be subjected to the short-term load test described in Subsection 1013-3.02(E).

From each lot of bearings designed by Method B of AASHTO Bridge Specifications Division I, Article 14.4, a random sample shall be subjected to the long-term load test described in Subsection 1013-3.02(F). 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) Testing by Contractor:**

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.

The contractor shall, at no additional cost to the Department, have the sample elastomeric bearing pads tested by a testing laboratory. The testing laboratory shall be approved by the Engineer, shall be not 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, 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) Low temperature test
- (4) Visual inspection
- (5) Shear modulus test
- (6) Bond and peel strength tests

The heat resistance tests shall be performed in accordance with Subsection 1013-3.02(B).

Shear stiffness tests shall be performed on material from a random sample of the finished bearings in accordance with Subsection 1013-3.02(G).

Cold bonding of individual laminated pads and peel strength tests shall be performed in accordance with Subsection 1013-3.02(H).

## **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 and shall be tested in accordance with ASTM D 429, 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 D 4014. It 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) Low Temperature Tests on the Elastomer:**

Grade 3 elastomer shall be subjected to low temperature brittleness tests (ASTM D 746), instantaneous low temperature stiffness tests (ASTM D 1043), and low temperature crystallization tests (ASTM D 4014). Grades 0 and 2 elastomers shall be subjected to instantaneous low temperature stiffness tests (ASTM D 1043). The tests shall be performed in accordance with the requirements of Table 1013-1, and the compound shall satisfy all limits for its grade.

**(D) Visual Inspection of the Finished Bearing:**

Every finished bearing shall be inspected for compliance with dimensional tolerances and for overall quality of manufacture. In steel reinforced bearings, the edges of the steel shall be protected everywhere from corrosion.

**(E) 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.

**(F) 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.

**(G) 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 D 4014, 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.

**(H) Bond and Peel Strength Tests:**

Cold bonding between individual laminated pads, if used, shall be tested in accordance with the requirements of California Test 663.

The peel strength test shall be performed in accordance with ASTM D 429, 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 Compliance, conforming to the requirements of Subsection 106.05, shall be submitted to the Engineer by the contractor upon delivery of geosynthetic materials for use on a specific project. If the delivered materials have not been evaluated and preapproved as noted below, it will be necessary for a Certificate of Analysis to be submitted to the Engineer along with the supporting documentation before the material may be considered for use on the project. Each geosynthetic material lot or shipment must be approved by the Engineer before the materials may be incorporated in the work.

Certificates of Analysis, conforming to the requirements of Subsection 106.05, may be submitted, along with a representative sample of appropriate size for testing, by the supplier or manufacturer of any geosynthetic material to ADOT Materials Group for evaluation and preapproval. Testing methods and results shown in the Certificate of Analysis shall conform to the listed specifications for the proposed geosynthetic use. Supporting documentation including, but not limited to, product information sheets, installation procedures and recommendations, recommended use, and project references shall also be submitted by the supplier or manufacturer as part of product evaluation and preapproval.

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 will be in a manner to prevent damage, contamination, or deterioration of the materials.

Samples of geosynthetic materials shall be submitted for testing. No samples shall be taken within five feet of either end of a roll. Samples

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shall be a minimum of three feet long by the full roll width. A minimum of one sample shall be taken per lot. More samples may be required as determined by the Engineer.

### 1014-2 Pavement Fabric:

Pavement fabric shall be a geotextile fabric material, constructed of nonwoven synthetic fibers of polyester or polypropylene. The pavement fabric shall be resistant to chemical attack, rot, and mildew, and shall have no tears or defects which will adversely alter its physical properties. The fabric shall be specifically designed for the designated pavement application, as a stress relieving membrane between two successive asphalt layers. The fabric material shall additionally conform to the following physical requirements:

Property	Requirement	Test Method
Weight: oz./sq. yd.	3.5 - 6.0	ASTM D 3776
Grab tensile strength: lbs.	80 minimum*	ASTM D 4632
Elongation at break: percent	50 minimum*	ASTM D 4632
Fabric thickness: mils	25 to 100	ASTM D 461
Melting point: degrees F	300 or greater	ASTM D 276
Asphalt Retention: gal./sq. yd.	0.2 minimum	Task Force 25, Method 8
*Minimum - Average value in weaker principal direction. All numerical values represent minimum average roll values, i.e., the average test result in the weak direction for a lot shall meet or exceed the minimum values listed when sampled according to ASTM D 4354 and tested according to the test method specified above.		

The width of the fabric shall be appropriate for the proposed construction. Longitudinal fabric joints shall meet the same location requirements shown in Subsection 406-6 for pavement joints.

### 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 geogrid shall be one of the following structure types:

- (A) A structure comprised of punched and drawn polypropylene or high density polyethylene sheet to form a grid.
- (B) A structure comprised of high density polyethylene or polypropylene extruded to form a grid.

The geogrid shall have high tensile strength and modulus in both principal directions, perpendicular to each other. The geogrid polymer materials shall contain stabilizers or inhibitors or shall be coated or encapsulated to prevent degradation of properties due to ultraviolet light exposure. The polymer shall also be inert to all naturally occurring alkaline and acidic soil conditions. The geogrid material shall additionally conform to the following physical requirements:

<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Average Aperture Size: inch MD, Note (2) XD, Note (3)	0.8 - 2.0 0.8 - 2.0	I.D. Calipered, (1)
Open Area: %	70 min., (4)	COE Method, (5)
Weight: oz./yd.	5.5 min.	ASTM D 3776
Thickness: mils At Rib At Junction	30 min. 60 min.	ASTM D 1777
Wide Width Strip Tensile Strength: lb./ft. At 2% Strain At 5% Strain At 15% Strain or Ultimate	275 min. 550 min. 800 min.	ASTM D 4595
Flexural Rigidity: mg-cm	250,000 min.	ASTM D 1388
Junction Strength: %	80 min.	ASTM D 638 Mod,(6)
(1) Maximum inside dimension in each principal direction measured by calipers. (2) MD-Machine direction which is along roll length. (3) XD-Cross machine direction which is across the roll width. (4) Minimum - Average value in weaker principal direction. All numerical values represent minimum average roll values, i.e., the average test result in the weaker principal direction shall meet or exceed minimum values listed when sampled according to ASTM D 4354 and tested according to the test method specified above. (5) Percent open area measured without magnification by the Corps of Engineers Method as specified in CW 02215, Civil Works Construction Guide, November 1977. (6) Junction strength is measured as a percent of ultimate single rib strength by tensile loading test ASTM D 638 modified to clamp the horizontal and vertical ribs of a "T" shaped specimen, with the grid junction forming the cross of the "T", and with a constant rate of extension of the specimen applied across the junction at a rate of two inches per minute at a temperature of 68 degrees F.		

The width of the geogrid shall normally be approximately 13 feet or as appropriate for the proposed construction. Longitudinal geogrid joints shall meet the same location requirements shown in Subsection 406-6 for pavement joints.

#### **1014-4 Separation Geotextile Fabric:**

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Separation geotextile fabric shall be a non-woven or woven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed or woven into a stable network such that the filaments retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties. 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. Physical requirements for nonwoven or woven fabrics for each survivability rating are listed in Subsections 1014-4.01, 1014-4.02, 1014-4.03, and 1014-4.04.

**1014-4.01 Low Survivability Fabric:**

**(A) Nonwoven:**

Low survivability, nonwoven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	90	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	30	ASTM D 4833
Burst Strength: psi	130	ASTM D 3786
Trapezoidal Tear: lbs.	30	ASTM D 4533
Permittivity: second <sup>-1</sup>	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 - 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

**(B) Woven:**

Low survivability, woven separation fabric shall meet the physical requirements listed in Subsection 1014-4.02(A) for moderate survivability non-woven fabric except that the grab elongation at break, percent, shall be 13 minimum, 115 maximum.

**1014-4.02 Moderate Survivability Fabric:**

**(A) Non-woven:**

Moderate survivability, nonwoven separation fabric shall meet the following minimum average roll values:

<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Grab Tensile Strength: lbs.	140	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	50	ASTM D 4833
Burst Strength: psi	210	ASTM D 3786
Trapezoidal Tear: lbs.	40	ASTM D 4533
Permittivity: second <sup>-1</sup>	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

**(B) Woven:**

Moderate survivability, woven separation fabric shall meet the physical requirements listed in Subsection 1014-4.03(A) for high survivability nonwoven fabric except that the grab elongation at break, percent, shall be 13 minimum, 115 maximum.

**1014-4.03 High Survivability Fabric:****(A) Nonwoven:**

High survivability, nonwoven separation fabric shall meet the following minimum average roll values:

<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Grab Tensile Strength: lbs.	200	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	75	ASTM D 4833
Burst Strength: psi	320	ASTM D 3786
Trapezoidal Tear: lbs.	50	ASTM D 4533
Permittivity: second <sup>-1</sup>	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

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Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

**(B) Woven:**

High survivability, woven separation fabric shall meet the physical requirements listed in Subsection 1014-4.04(A) for very high survivability nonwoven fabric except that the grab elongation at break, percent, shall be 13 minimum, 115 maximum.

**1014-4.04 Very High Survivability Fabric:**

**(A) Nonwoven:**

Very high survivability, nonwoven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	270	ASTM D 4632
Grab Elongation at Break: %	45 min., 115 max.	ASTM D 4632
Puncture Strength: lbs.	110	ASTM D 4833
Burst Strength: psi	430	ASTM D 3786
Trapezoidal Tear: lbs.	75	ASTM D 4533
Permittivity: second <sup>-1</sup>	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

**(B) Woven:**

Very high survivability, woven separation fabric shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	340	ASTM D 4632
Grab Elongation at Break: %	13 Min., 115 Max.	ASTM D 4632
Puncture Strength: lbs.	130	ASTM D 4833
Burst Strength: psi	500	ASTM D 3786
Trapezoidal Tear: lbs.	90	ASTM D 4533
Permittivity: second <sup>-1</sup>	0.07	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

#### **1014-5 Bank Protection Fabric:**

Geotextile fabric to be used behind bank protection such as rip rap, rail bank, or gabions as called out on the project plans shall be a woven monofilament fabric or nonwoven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed into a stable network such that the filaments retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties. The physical requirements for the bank protection fabric shall be as specified in Subsection 1014-4.03(A) except that the grab elongation at break, percent, shall be 15 minimum, 115 maximum, and the permittivity shall be 0.50 minimum.

#### **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 wall drain core material shall consist of a preformed, stable, polymer plastic material with a cusped, nipped, 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 weephole drainage outlets. If not perforated during manufacture, the core shall be perforated in the field at the weephole



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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 minimum physical requirements:

Property	Requirement	Test Method
Thickness with Fabric: inch	0.23 (1)	ASTM D 1777
Compressive Strength: psf	6,000	ASTM D 1621
Transmissivity; Gradient = 1.0, Normal Stress = 3000 psf, gal./min./ft.	4.0	ASTM D 4716
(1) Minimum average roll value, i.e., the average test result for a lot shall meet or exceed the minimum value listed when sampled and tested according to the specified test method.		

The geocomposite core shall be furnished with an approved method for connecting with outlet pipes or weepholes 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 geotextile wall drain fabric shall be laminated onto or adhere to the side of the drainage core which will face the backfill. The geotextile fabric shall be a non-woven polyester or polypropylene fabric meeting the following minimum average roll values:

Property	Requirement	Test Method
Weight: oz./sq. yd.	3.5	ASTM D 3776
Grab Tensile Strength: lbs.	90	ASTM D 4632
Grab Elongation at Break: %	35 min., 115 max.	ASTM D 4632
Mullen Burst Strength: psi	140	ASTM D 3786
Trapezoidal Tear: lbs.	30	ASTM D 4533
Puncture Strength: lbs.	30	ASTM D 4833
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Permittivity: second <sup>-1</sup>	0.50	ARIZ 730
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

A minimum three-inch wide flap of geotextile fabric shall extend beyond both longitudinal edges of the geocomposite core. The geotextile 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 shall be resistant to commonly encountered chemicals and hydrocarbons, and resistant to ultraviolet exposure.

**1014-7.01                Geocomposite Edge Drain Core:**

The edge drain core material shall consist of a preformed, stable, polymer plastic material with a cusped, nipped, 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 weephole drainage outlets. If not perforated during manufacture, the core shall be perforated in the field at the weephole 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 minimum physical requirements:

Property	Requirement	Test Method
Thickness Wrapped with Fabric: inch	0.75 (1)	ASTM D 1777
Compressive Strength: psf	4,000	ASTM D 1621
Transmissivity; Fabric Wrapped Core, Gradient = 0.1, Normal Stress = 1500 psf, gal./min./ft.	4.0	ASTM D 4716, (2)
Width: ft.	1.0 (3)	Measured
Notes: (1) Minimum average roll value, i.e., the average test result for a lot shall meet or exceed the minimum value listed when sampled and tested according to the specified test method. (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 geotextile edge drain fabric shall completely wrap around the drainage core material in a snug manner and may be permanently bonded to the core. The geotextile fabric shall be a non-woven polyester or polypropylene fabric meeting the following minimum average roll values:

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Property	Requirement	Test Method
Weight: oz./sq. yd.	3.5	ASTM D 3776
Grab Tensile Strength: lbs.	90	ASTM D 4632
Grab Elongation at Break: %	35 min., 115 max.	ASTM D 4632
Mullen Burst Strength: psi	140	ASTM D 3786
Trapezoidal Tear: lbs.	30	ASTM D 4533
Puncture Strength: lbs.	30	ASTM D 4833
Apparent Opening Size: U.S. Standard sieve size	30 – 140	ASTM D 4751
Permittivity: second <sup>-1</sup>	0.50	ARIZ 730
Ultraviolet Stability: %	70	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above. If the average grab elongation of the fabric is greater than 115 percent at break, the elongation will be acceptable if the grab tensile strength requirement is met prior to or at 115 percent elongation.

### 1014-7.03 Outlet Pipes:

The pipe for the edge drain outlet lateral shall be rigid, four-inch diameter, Schedule 40 PVC pipe conforming to the requirements of ASTM D 1785, Schedule 40 polyethylene pipe conforming to the requirements of ASTM D 2104, or Schedule 40 ABS pipe conforming to the requirements of ASTM D 1527.

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:

The geotextile silt fence fabric shall be a nonwoven or woven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed or woven into a stable network such that the filaments retain their position relative to each other.

The fabric shall contain a stabilizer and/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 sewn or 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 all 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 140 degrees F.

The fabric shall meet the following average roll values:

Property	Requirement	Test Method
Grab Tensile Strength: lbs.	100 min.	ASTM D 4632
Elongation at 50 % of min. tensile strength (60 lb.): %	50 max.	ASTM D 4632
Permittivity: second <sup>-1</sup>	0.05 min.	ARIZ 730
Apparent Opening Size: U.S. Standard sieve size	30 max.	ASTM D 4751
Ultraviolet Stability: %	70 min.	ASTM D 4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D 4354 and tested according to the test method specified above.

#### **1014-9 Drainage Fabric:**

Drainage geotextile fabric shall be used in the following applications: pavement edge drains, interceptor drains, underdrains, wall drains, recharge basins, and relief wells.

Drainage geotextile fabric shall be a non-woven fabric consisting only of long chain polymeric filaments such as polypropylene, polyethylene, or polyester formed into a stable network such that the filaments retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties.

The physical requirements for the drainage fabric shall be as specified in Subsection 1014-4.02(A) for moderate survivability non-woven separation fabric except that the permittivity requirement for drainage fabric shall be 0.50 second<sup>-1</sup>.

### **SECTION 1015 EPOXY MATERIALS:**

#### **1015-1 General Requirements:**

Certificates of Compliance, conforming to the requirements of Subsection 106.05(B), shall be submitted to the Engineer by the contractor for any epoxy materials used on a specific project. The epoxy material must be on the current ADOT Approved Products List

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(APL) prior to submittal for use on an ADOT project. Copies of the most current version of the APL are available on the internet from the Arizona Transportation Research Center (ATRC), through its PRIDE program. The epoxy material must be approved for the use or application for which it is intended.

The contractor shall submit product literature and Material Safety Data Sheets (MSDS). 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 material 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 material.

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 materials shall be stored in accordance with the manufacturer's recommendations at all times. Attention is directed to the characteristic of some epoxy 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 materials shall be in accordance with the manufacturer's recommendations unless otherwise specified by the Engineer. Use of epoxy materials 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 material shall be at a temperature between 60 and 85 degrees F, unless otherwise specified or approved by the Engineer. Any heating of the epoxy components shall be done by application of indirect heat.

Immediately prior to mixing, each component shall be thoroughly mixed with a paddle. Separate paddles shall be used to stir each component.

Immediately prior to use, the components of the epoxy materials shall be mixed together in the specified ratios according to the manufacturer's recommendations. When mixed, all epoxy materials shall have a uniform color without streaks. No solvent shall be added to any epoxy.

Surfaces on which the epoxy 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 has begun.

When epoxy is used as a binder to make epoxy mortar, the components of the epoxy 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 adhesive to make epoxy 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 epoxy mortar is to be placed shall be primed with a coat of the epoxy adhesive just prior to placing the epoxy mortar.

#### **1015-2            Epoxy Resin Base Anchoring Adhesive:**

Epoxy resin base anchoring adhesive shall be used in anchoring dowels or tie bars into concrete. For horizontal applications where flow out of the anchoring hole is a problem, high viscosity or non-sag epoxies in the form of a gel are to be used. Low and medium viscosity epoxies may be used in vertical holes which open upward. The product shall specifically be designed for this application according to the manufacturer's product literature.

Epoxy resin base anchoring material shall provide a minimum pullout resistance of 13,200 pounds when tested in accordance with Arizona Test Method 725. The pot life of the material shall be determined in accordance with AASHTO T 237, Part I. The pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater.

#### **1015-3            Epoxy Resin Base Adhesives:**

##### **(A)            General:**

The grade of the epoxy 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. The pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater. Epoxies with high early

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strength development as stated by the manufacturer will be tested for conformance to the manufacturer's claims.

### **(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 C 881, Type I for non-load bearing applications and Type IV for load bearing applications. Epoxy resin base adhesive shall be tested in accordance with the requirements of ASTM C 882 and shall provide a slant shear compressive strength of 1,000 pounds per square inch at two days and 1,500 pounds per square inch at 14 days. The compressive strength shall be determined in accordance with ASTM C 109 for two-inch cube specimens except that the epoxy materials shall be tested without the addition of sand, and for low viscosity materials which readily flow, no tamping is necessary. The compressive strength determined at seven days shall be 8,000 pounds per square inch for Type I epoxy and 10,000 pounds per square inch for Type IV epoxy.

### **(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 C 881, Type II, for non-load bearing applications and Type V for load bearing applications. Epoxy resin base adhesive shall be tested in accordance with the requirements of ASTM C 882 and shall provide a slant shear compressive strength of 1,500 pounds per square inch at 14 days. The compressive strength shall be determined in accordance with ASTM C 109 for two-inch cube specimens except that the epoxy materials shall be tested without the addition of sand, and for low viscosity materials which readily flow, no tamping is necessary. The compressive strength determined at seven days shall be 5,000 pounds per square inch for Type II epoxy and 8,000 pounds per square inch for Type V epoxy.

### **1015-4 Epoxy Resin Base Binder for Epoxy Mortar:**

Epoxy resin base materials to be used for binder in epoxy mortar, shall conform to the requirements of ASTM C 881, Type I, for non-load bearing applications and Type IV for load bearing applications. The grade of the epoxy 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.

Epoxy resin base adhesive for use as binder in epoxy mortar shall be tested in accordance with the requirements of ASTM C 882. In this test, the upper half of the slant shear test shall be molded epoxy mortar with the epoxy adhesive and sand or aggregate material mixed together as specified and in the proportions as recommended by the manufacturer. Prior to placing the epoxy mortar, the same epoxy

adhesive shall be applied to the underlying concrete slant shear surface. The epoxy adhesive and mortar tested in this manner shall provide a slant shear compressive strength of 1,000 pounds per square inch at two days and 1,500 pounds per square inch at 14 days. The pot life of the mixed epoxy mortar shall be determined in accordance with AASHTO T 237, Part I. The pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater. The compressive strength of the epoxy mortar shall be determined in accordance with ASTM C 109 for two-inch cube specimens. The epoxy material shall be tested with the addition of sand, mixed together as specified and in the proportions as recommended by the manufacturer. The compressive strength determined in this test at seven days shall be 8,000 pounds per square inch for Type I epoxy and 10,000 pounds per square inch for Type IV epoxy. Epoxies with high early strength development as stated by the manufacturer will be tested for conformance to the manufacturer's claims.

#### **1015-5                   Epoxy Resin Base Adhesive for Crack Repair:**

Epoxy resin base materials 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 base adhesive shall conform to the requirements of ASTM C 881, Type I, for use in non-load bearing applications and Type IV for use in load bearing applications. The grade of the epoxy 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.

The epoxy resin base adhesive for crack repair shall be tested in accordance with the requirements specified in Subsection 1015-3(B).

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), 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



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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.

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 C 387.

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.

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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 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 two inches, shall conform to the requirements of ASTM C 387, 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 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 two inches shall conform to the requirements of ASTM C 387. 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 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 C 928.

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 of the mixing water.

If the material contains soluble chlorides or other ingredients in sufficient quantity to cause corrosion to steel reinforcement, the material will not be acceptable.

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 C 882 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 C 157, except as modified in ASTM C 928, Sections 8.3 and 7.3. Based on the lengths of three-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 three 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 C 928.

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 of the mixing water.

If the material contains soluble chlorides or other ingredients in sufficient quantity to cause corrosion to steel reinforcement, the material will not be acceptable.

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.

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Very rapid-hardening concrete materials shall be tested in accordance with the slant shear requirements of ASTM C 882 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 C 157, except as modified in ASTM C 928, Sections 8.3 and 7.3. Based on the lengths of three-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 three 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 C 928.

The packaged dry rapid hardening mortar material shall conform to the same requirements for rapid hardening concrete listed in Subsection 1016-5 except that the compressive strength shall be determined on mortar cubes, the length changes will be determined using one-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 C 928.

The packaged dry very rapid hardening mortar material shall conform to the same requirements for very rapid hardening concrete listed in Subsection 1016-6 except that the compressive strength shall be determined on mortar cubes, the length changes will be determined using one-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(B) shall be submitted to the Engineer by the contractor for any nonshrink grout materials used on a specific project. The nonshrink grout material must be on the current ADOT Approved Products List prior to submittal for use on an ADOT project. The nonshrink grout material must be approved for the use or application for which it is intended and shall meet the requirements of CRD-C621-83, Corps of Engineers Specification For Nonshrink Grout, 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.

**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

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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 C 882 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.

The compressive strength shall be determined in accordance with the requirements of CRD-C621-83, Corps of Engineers Specification For Nonshrink Grouts. The minimum compressive strength at seven days shall be 2,500 pounds per square inch and the minimum compressive strength at 28 days shall be 5,000 pounds per square inch. Nonshrink grouts with high early strength development as stated by the manufacturer will be tested for conformance to the manufacturer's claims. The compressive strength of nonshrink grout material at 28 days shall be equal to or greater than the 28 day compressive strength requirement of the concrete to be patched.

The expansion percent for the nonshrink grout material shall be determined in accordance with the requirements of CRD-C621-83. The maximum expansion shall be 0.4 percent when measured at 3, 14, and 28 days. The percent shrinkage at 28 days shall be zero.



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