701 MAINTENANCE AND PROTECTION OF TRAFFIC

701-1 Description

One of ADOT's primary goals for any construction project is the safe and efficient handling of traffic through and around construction zones with as little inconvenience and delay as possible. The constant watchfulness by the Resident Engineer (RE) and all inspection personnel is necessary to accomplish this goal. The highest concern should always be the safety of the public, workers, and Inspectors. The convenience of the Contractor is never to be placed above safety when planning or approving traffic control. Safety to the general public, mitigation of economic loss as a result of delays, and good public relations are the benefits of diligent, intelligent traffic handling.

Often a traffic control plan will appear in the Project Plans. The Inspector must evaluate the traffic plan based on the conditions found at the work site. The Inspector or Resident Engineer can have the plan reviewed by the Regional Traffic Engineer when a second opinion is needed. During the project, the contractor's and ADOT's traffic control representatives shall have a current copy of the approved traffic control plan.

Usually traffic handling needs will depend on the way the Contractor chooses to construct the project. As a result, it may be necessary to plan the traffic control to fit the construction sequencing. The Contractor and ADOT's field staff can use their ingenuity to reduce traffic control clutter, confusion, and cost. An example of this may be to use painted traffic control delineation rather than vertical panels.

MUTCD references in this section refer to the adopted editions of both the Manual on Uniform Traffic Control Devices (MUTCD) and the Arizona Supplement to the Manual on Uniform Traffic Control Devices.

Detours

In a construction zone that carries considerable traffic, it is often preferable to provide a route which will take the traffic around the construction zone. When detours are practical but no detour plans are included, or when the detour plans provided must be modified, it may be necessary for the Contractor and the Resident Engineer to take the initiative to design the detour. If the Contractor is proposing a detour as part of his traffic control, the complete design of the detour would be the Contractor's responsibility. It is usually necessary to obtain local government approval when city streets are used for detours.

It is desirable that both ends of the detour are visible to approaching motorists. Transitions should not be in close proximity to horizontal or vertical curves, structures, or any obstruction which would interfere with the motorist's view of the transition. One ideal situation is to locate entering transitions on far sides of sag vertical curves so that the complete detour is visible (like a huge map) to the motorists. Detour plans call for a great deal of thought, planning, and on-the ground investigation. Plans for detours should be drawn to include the applicable standards and submitted for the approval of the Regional Traffic Engineer. Add that detours shall be constructed (if needed) in accordance with chapter 2 etc.

Speed Limits

The District Engineer has the authority to change the legal speed limits in construction work zones. Speed limits should be reduced only to the minimum amount necessary and in 10 mile per hour increments, to ensure safe conditions for drivers and workers. Traffic passing through a construction work zone is not a legitimate reason in itself for reducing speeds. Furthermore, speed limits should not be reduced when no hazards or work activities are present.

Flagging

Both the Resident Engineer and the Contractor should be aware that flagging for haul vehicles is set up to reduce the hazard to street traffic caused by crossing vehicles. Although the street traffic is better protected from haul traffic when the street traffic is stopped, there is an inherent risk of motor vehicle accidents when frequently

stopping traffic. As a result, the flaggers must be instructed not to stop street traffic for any non-haul vehicles. Non-haul vehicles can cross during the first available gap. Fewer traffic breaks mean a safer cross haul operation. Street traffic stopped for an equipment crossing is more vulnerable to an accident if they have not been warned. Proper warning is of benefit to both the street traffic and the Contractor. No traffic should be stopped until approved warning signs are in place, and warning signs must be removed if no hauling/crossing is in progress. Certifications are needed for the civilian flaggers and must be verified on the American Traffic Safety Services Association (ATSSA) website.

Traffic Control Documentation

The courts have made it clear that liability will follow if written standards and requirements for traffic control are not followed faithfully. This not only means that the placement of traffic control devices must be correct, but also that the size, physical condition, cleanliness, and every other requirement must be met.

Good records of traffic control facilities will include:

- Dates and times of day that inspections are made
- Statement of conditions found
- Complete listing of type, size, and location of devices
- Orders to the Contractor to make changes or corrections
- Time and date that devices are removed or modified
- Photographs
- Comments explaining any variations from standard procedures

Additionally, it is a good practice to videotape the project traffic control following the initial setup and periodically thereafter. Remember, although traffic control is the responsibility of the Contractor, the State may also incur liability due to its action or inaction. Photographs of accidents are all too often of the accident vehicles themselves. ADOT personnel must develop the habit of photographing all the approaches to the accident site, photographing the signs and conditions on the approaches, and photographing a view backwards along the vehicle paths. As with all photographic and video documentation, the photographs and videos must be logged, referred to in the diary, and filed with the project records. Inspectors must document facts, comments, and observations of the accident, but must be careful not to express individual opinions.

Inspection Guidelines for Traffic Control

- Have traffic control representatives been appointed by the Contractor and the State?
- Is traffic being controlled in accordance with the specifications, special provisions, the ADOT Temporary Traffic Control Design Guidelines and the MUTCD? Are all local regulations being followed?
- Are flaggers properly outfitted with hard hats and either international orange shirts or vests during daylight hours? Are reflective vests and illumination utilized during poor light?
- Are flaggers properly equipped and trained in conformance to the ADOT Temporary Traffic Control Design Guidelines and the MUTCD?
- If traffic delay has caused a long line of waiting vehicles, are two flaggers being used for each direction of traffic movement (one at the head and one at the tail)?
- Is traffic being stopped for haul vehicles only?
- Are flaggers informing the public of the reason for the delay and instructing them to stay in line and not pass the vehicle ahead while within the controlled traffic section?
- Are pilot cars being used when required?
- Are the necessary signs being used, and do they conform to the requirements of the ADOT Temporary Traffic Control Design Guidelines and the MUTCD?
- Are devices being maintained in a clean and legible condition?
- Are signs being installed only when needed and promptly removed or covered when the traffic control setup is taken down?

- When any type of closure or detour of the traveled way has been made, has all conflicting signing and striping that might mislead the traveling public been covered or obliterated?
- Are there any rough spots, loose material, or surprise hazards in the detour or construction zone that should be repaired or more adequately signed?
- Is the Contractor making repairs and checks on their own initiative? Are they ignoring needed work until informed that it must be done? (Document this.)
- If a detour is not paved, is adequate dust palliative being applied for the safety and convenience of the motorists? Is it adequate to prevent a nuisance to residents or a hazard to crops in the area?

701-2 Materials (Equipment, Workers, Devices, and Facilities)

701-2.01(B)(1) Safety

The Specifications require the contractor to have reports which verify that certain devices meet a specified criteria. Copies of such reports shall be kept in project files and accessible to the project supervisor and inspectors, payment can be withheld for items that do not have required documentation.

701-2.02 Flashing Arrow Panels

The MUTCD refers to a number of performance values for arrow displays or flashing arrow panels that are not easily verifiable in the field. To document such things as candlepower, dimming range, beam spread, etc.; the Inspector can find this information in the manufacturer's literature which can be obtained from the Contractor. Arrow-boards are not to be used as substitutes for signs, barricades, or other devices, but rather as supplemental devices. Arrow boards should be in good condition, have reliable components, and must not leak lubricants or fuel, both of which are hazardous and detrimental to the pavement. The Contractor will be required to repair any damage caused by the equipment. Diesel generators on arrow-boards are preferred over gasoline generators because diesel generators have a lesser risk of explosion or fire from an impact to the fuel tank.

701-3 Construction Requirements

701-3.01 General

The specifications require that the Contractor provide an employee qualified to implement, monitor, and modify the traffic control plans associated with the project. This employee's name and the means to contact him in the event of an emergency shall be provided to the Resident Engineer at the Preconstruction Conference.

The Resident Engineer should designate a Department employee who will be responsible to monitor the traffic control and ensure that traffic is handled safely and efficiently.

The Standard Specifications allow the Resident Engineer to either suspend the work or have traffic control measures performed by others, at the Contractor's expense, in case of serious or willful disregard for the safety of the public or construction personnel. The Resident Engineer should allow the Contractor every opportunity to take corrective measures prior to taking such action. If it becomes necessary for the Resident Engineer to take action, the actions should be discussed in advance with the District Engineer unless public safety is seriously at risk.

701-3.02 Maintenance and Protection of Traffic

Inspectors and Field Engineers must make sure that the traffic control is maintained in the original condition. Items such as dirty barricades and lights must be cleaned. Flags that have faded from their "International Orange" color must be replaced. Obscured striping must be exposed. Dirt and stones on the roadway must be removed. A good guide for inspection is the ATSSA Quality Standards for Work Zone Traffic Control Devices.

Traffic control features must be installed in strict conformance with the MUTCD and the ADOT Temporary Traffic Control Design Guidelines to enhance safety through consistency and to reduce the risk of liability for both the

Contractor and the State. Given the increase in litigation involved with traffic control, all parties must realize that hasty, undocumented changes of traffic control will increase the legal liability for everyone. Major modifications to the traffic control plans should be reviewed and approved by the Designer prior to implementation. Changes must never be made by personnel not trained in traffic control planning and implementation.

Should a local agency be involved with the project, the Resident Engineer is advised to meet with that local agency to get their interpretation, coordination, and approval for traffic control.

701-3.03 Temporary Concrete Barrier

Construction and installation drawings for concrete barriers are shown in the Project Plans or Standard Drawings. A review of the placement location should be made to ensure the barrier placement allows for drainage.

In order to function as designed, the barrier run must be a reasonably rigid structure. Barrier sections can be "stretched" after pinning to take up any slack in the pin connection. The foundation must be solid and uniform. The flare at the end of the barrier runs must not be installed on top of a curb and gutter. The curb and gutter must be removed to ensure that errant vehicles will not be launched over or into the barrier.

In some cases where a barrier is placed close to a vertical drop-off, it may be desirable to place steel pins at the backside of the barrier to prevent movement when impacted.

Some barrier sections have holes for pins. If pins are driven through the holes on the front face, the pins must not protrude above the front face of the barrier. The barrier sections must have uniform bearing on firm material to function properly. Styrofoam sheets are usually placed under the ends of barrier sections to provide uniform contact pressure when barriers are set on hard surfaces such as pavements.

All previously used barriers should be carefully inspected for badly chipped or cracked areas. Any badly damaged sections should be rejected. Delineation must be placed at proper intervals along the barrier. The barrier must meet the requirements of Signing and Marking Standard Drawing C-3.

End treatments for temporary concrete barriers are either impact attenuation or flared end. The criteria for selecting an end treatment is based on using an end treatment that will give the best protection for the least cost under the given conditions. The first criteria for use of an end treatment should be safety, not convenience or cost.

701-3.04 Temporary Impact Attenuation Devices

Two types of attenuation devices are commonly used by ADOT, an energy absorbing terminal and sand barrels crash cushion.

The energy absorbing terminal is more complicated than sand barrels but is more compact, and can be used where it is important to save space.

The Inspector should obtain a copy of the assembly diagrams and instructions for the installation inspection. The Inspector should see that the replacement parts package is properly stored in a convenient location; the package contains all the necessary parts; and any parts used are replaced in the package. The Standard Specifications require that a complete replacement package be on the project at all times whenever an energy absorbing terminal is being used.

Repair or replacement of an energy absorbing terminal should begin immediately after the damage occurs. When damage occurs at night or during severe weather, the repair or replacement should not be delayed longer than the next day. The Resident Engineer must use some judgment to decide whether a damaged attenuator needs only extra warning signs until normal Contractor personnel are available, or whether to call the Contractor and reimburse him or her premium overtime for immediate repair.

In either case, an attempt must be made to retrieve the money spent to repair the device. Following completion of the repairs, the costs should be calculated by the Resident Engineer and all related documentation forwarded to Risk Management for insurance recovery.

Energy absorbing terminal devices are anchored to the road surface by bolting them to a concrete slab or by pins when placed on asphaltic concrete. Whichever method of anchoring the device is used, the manufacturer's recommendations are to be followed exactly. Never permit improper installation of safety devices. Escalate the issue to the District level if necessary. If the devices are not installed properly, the facts are to be documented and the Contractor must be notified in writing.

Although the installation of sand barrels is not complicated, it is still important that erection instructions are followed carefully, and materials used to fill the barrels are in compliance with subsection 702-2.03. The foundation must be uniform, the correct interior parts must be used, and barrels containing the right amount of dry sand at each location are to be placed in the specified geometric pattern. If sand barrels are installed above 3,000 ft elevation, the sand shall be thoroughly mixed with a minimum of 5% (by weight) rock salt. All of the above precautions need to be rechecked carefully during repair of damaged installations. Barrel material should either be pre-certified by the Structural Materials Testing Section or the material must be sampled and tested. If rock salt is to be used, a sample of both the sand and the sand-rock salt mixture are required.

Sand barrels should not be installed and forgotten. They are subject to vandalism, so they should be checked periodically.

701-3.05 Temporary Pavement Markings (Application)

The most commonly used temporary pavement markings are raised markers, paint, and reflective tape. Unless the surveying is done by ADOT, the Contractor is to perform the basic layout.

Control points must be set at a frequency and accuracy that encourages the striping to be placed with uniform, eye-pleasing alignment (normally accomplished in 50-foot intervals). There are no placement tolerances for temporary marking, but this should not be used as an excuse for accepting poor workmanship. It is important for the Inspector to meet with the Contractor's representatives to agree on placement tolerances before any striping work is started.

The first option for temporary pavement marking should be paint since it is less expensive than tape or raised pavement markers. When applying paint as a temporary pavement marking, it should be applied as if it were permanent. Ensure that the correct width, thickness, and bead content are achieved. See Section 708 for requirements of Temporary Pavement Markings paint.

When striping with plastic tape, it is sometimes possible to correct the alignment by pulling it up and replacing it, provided that this is done before it has become firmly stuck. The activator used to enhance the adhesive properties in cool weather may help to restore stickiness to the adhesive when the tape has been pulled up.

Delineators and markers used for temporary traffic control may be reused as permanent devices if they are undamaged or if slight damage is adequately repaired. There is no obligation on the part of ADOT to allow the reuse of pavement-marking materials that are not in first-class condition.

Temporary Pavement Marking Procedures

The ADOT Temporary Traffic Control Design Guidelines describes ADOT’s policy on temporary striping and temporary pavement markings as they apply to construction work. The Department does require some type of pavement markings to be in place before any section of roadway is opened to traffic. Traffic should not be allowed to run on unmarked pavement.

Permanent pavement markings should be placed as soon as possible. Temporary pavement marking should only be used when weather conditions, scheduling conflicts, or unfinished construction prohibit the placement of the permanent pavement markings.

Use Type II (Temporary-Removal) preformed pavement markings if eventual removal is required. Use Type III (Temporary-Nonremovable) preformed pavement markings, and/or temporary marking paint when removal of markings is not required. For example; Type III preformed pavement markings could be placed on the lower AC lift surfaces, then Type II placed on top of the ACFC, or chip seal surface. The Type II temporary markings would be removed just prior to application of permanent markings.

A 4-foot centerline stripe placed at 40-foot intervals must be used for intermediate lifts of overlays. Temporary pavement markers placed in accordance with Standard Signing and Marking Drawing M-20 should be used for temporary pavement markings on chip seal projects. On freeways and interstate highways only temporary painted stripes should be used to delineate lane lines and centerlines. For severe curves, a 2-foot stripe placed at 20-foot intervals should be used.

Temporary pavement markings should be used for delineation instead of barricades when the duration will exceed five days, or the lane width is less than 12-feet.

701-3.06 Obliteration of Existing Pavement Markings

Removal of pavement marking can be done by any means that will not leave an illusion that the pavement marker is still there. Sandblasting or wet blasting are two acceptable methods. Painting or flushing with asphalt will leave a shiny surface that looks like a paint stripe under adverse conditions (usually at times when it is most important that obliteration is complete) and is not an acceptable method.

Areas where pavement markings have been removed should be checked at night and during wet weather to verify that the removal is effective under these conditions.

Removal of lead-based markings is hazardous, and must be done in compliance with 29 CFR for Lead Exposure in Construction. The contractor must submit a lead exposure plan prior to obliterating lead-based markings.

701-3.07 Truck Mounted Attenuator

The purpose of a truck-mounted attenuator (TMA) is to decelerate the impacting vehicle at a rate which prevents serious injury to the vehicle occupants. Each type of TMA has specific vehicle weight requirements in which it will operate in an acceptable manner. The Inspector should check to verify that the truck on which the TMA is mounted is the appropriate weight for the application. The TMA should be positioned a sufficient distance ahead of the workers or equipment to allow for the appropriate vehicle roll ahead (distance the vehicle will move during impact). For stationary operations the TMA should be down and locked, wheels locked, parking brake set, and wheels turned away from the work site and traffic. The vehicle on which the TMA is mounted should not be allowed to be used as a utility vehicle, but dedicated to the purpose of work zone safety.

701-3.08 Changeable Message Board

The benefit of changeable message boards (CMB) is the flexibility to display a variety of messages to fit the needs of the situation. CMBs are called portable changeable message signs (PCMS) in the MUTCD. The CMB typically consists of the following components: the message panel, control system, and the power source. The CMB should be clearly visible and legible from a distance of at least 800-feet under both day and night conditions.

The primary purpose of the CMB is to alert drivers to unexpected traffic and routing situations.

Typical applications include the following:

- Speed of traffic is expected to drop substantially

- Significant delays are expected
- There are alignment changes
- Provide advance warning of roadway closures

The CMB is not to be used as a stand-alone item of traffic control, but rather as a supplement to enhance the existing traffic control. The CMB should be offset at least 8-feet from the nearest traffic lane. When positioned on the highway, the changeable message board trailer shall be delineated with a minimum of 10 Type II barricades or vertical panels with Type C steady burn lights at a spacing of 10 to 20 feet, or as shown on the approved traffic control plan. Turn the message board away from traffic when not in use.

The format of the message is extremely important. No more than two message displays should be used within any message cycle. Each message should convey a single thought and should be as brief as possible. The flash rate should allow the entire message cycle to be read at least twice at the posted speed limit. Messages should be approved by the Regional Traffic Engineer when long duration setups are anticipated.

The acceptable type of CMB and message should be discussed during the pre-construction conference. The contractor must use a CMB on the Department's Approved Products List, or provide Certification of Compliance. See the Standard Specifications for a list of requirements.

701-3.13 Flagging Services

The Department recognizes three types of flaggers: civilian, local law enforcement with vehicle, and Department of Public Safety (DPS) with vehicle. All flaggers serve a similar purpose, to move traffic safely and expeditiously through or around work zones while protecting on site workers and equipment. When the project traffic control plans require the use of a flagger, the Resident Engineer will determine what type of flagger will be used. In the event that an officer and vehicle are required, either a DPS officer or an off-duty local Officer will be used, depending upon what jurisdiction the roadway falls under. DPS officers are preferred on interstates and urban freeways and shall be contacted for right of first refusal before utilizing local law enforcement officers.

Travel time up to 1 hour is allowed for Officer flagging. Anything over that will require preapproval from the State Construction Engineer.

Procurement of civilian, local law enforcement, and DPS flaggers is the responsibility of the Contractor.

701-4 Method of Measurement

The contractor will be reimbursed for Traffic Control by one of three ways depending upon how the "Elements of Work" are measured and paid. The inspector must read the project Special Provisions to determine which way is appropriate. The most common way is to require the contractor to bid every traffic control element of work. Item 7010005 is used for lump sum traffic control, see Special Provisions for elements included in the lump sum and what is paid for as listed below.

There are two basic methods for measuring traffic control: "Elements of Work". Some Elements of Work are measured once "Complete-in-Place" after installation and other elements are measured "In-Use" on a periodic basis. Except for Temporary Concrete Barrier and Temporary Impact Attenuators, no measurement for payment is made for relocating Elements of Work. The unit of measure for an In-Use Element will always have a periodic time dimension. For example: "Each-Day" is a common In-Use unit of measure.

701-4.03 Payment Exceptions

It is the intent of the Standard Specifications to reimburse the Contractor for maintenance and protection of traffic, provided that the traffic control plan and required devices are properly maintained and monitored. If the Contractor fails to properly implement the traffic control plan and maintain the required traffic devices, payment may be withheld until such time as deficiencies are corrected. Notification of such action must be in writing.

No payment will be made for traffic control serving a commercial pit or batch plant. Since these commercial operations serve other customers as well as ADOT, an equitable distribution for shared traffic control cost cannot be consistently made.

Hauling vehicles should not use median turnarounds within 1 mile of a traffic interchange (TI). The Contractor must be encouraged to make maximum use of the TI structure. Existing median turnarounds may be used in other areas, but new median crossings will not be constructed.

If the Contractor fails to work in a diligent manner and is ineffective in his or her use of traffic control devices, the Resident Engineer may determine not to reimburse the Contractor for these elements until proper progress is being made. The Contractor must be notified in writing of any such action.

The Contractor will not be reimbursed for elements of work if work is suspended as a result of the Contractor's fault, or upon expiration of contract time. It is the intent of this subsection that no payment will be made for traffic control during periods of liquidated damages.

Regardless of the circumstances for not reimbursing the Contractor for work elements, the Contractor is responsible for maintaining all traffic control devices in proper functioning condition at all times. Therefore, the Resident Engineer should continue monitoring the project during these times.

702 ATTENUATION DEVICES

Permanent installations of energy absorbing terminals are usually placed on a reinforced concrete pad. Unless otherwise specified on the project plans, the paved pad must be 4-inch thick utility concrete or asphalt. The type of bolt and anchorage called for in the installation instructions must be used as specified since the effectiveness of the attenuator depends on the anchorage being strong enough to withstand the design impact stresses. The inspector should verify the attenuation device is on the Department's current Approved Products or obtain approval from ADOT Traffic Group.

Alignment and slope of the attenuator are important for reasons of aesthetics and for the proper functioning of the unit. When permanent attenuators are constructed with salvaged material, or material that was obtained from a replacement package, all parts should be carefully examined for damage and compatibility with the existing attenuator parts. Field modifications of parts are not to be made unless they are approved by ADOT Traffic Group and the attenuator manufacturer.

The Standard Drawings give the dimensions, weights, and layout criteria for typical sand barrel installations. These layouts are to be used unless the Project Plans contain a separate detail for a given location.

The angles and weights shown in the drawings for the installation of sand barrels are not to be changed. The details shown in the drawings have been developed through calculations and testing to provide maximum protection for the design vehicle within a reasonable range of speeds. Any change in layout criteria may seriously affect the performance of the sand barrel array. As an aid to maintenance, it is helpful to paint the outline of each barrel and its sand weight on the concrete base. The placement of temporary sand barrels on pallets should not be allowed unless the manufacturer specifically approves this.

Inspectors are reminded that when sand barrel crash cushions are installed at elevations above 3,000 feet, a minimum of 5 percent rock salt (by weight) shall be thoroughly mixed with the sand.

Barrels which have been filled with sand and rock salt prior to delivery to the project require pre-certification. The Structural Materials Testing Section will mark the pre-certified barrels in stencil with a production lot number and a referenced ADOT test report. The project should confirm the test results are in compliance with specification requirements. If not stenciled, or markings are not legible, material must be sampled and tested for compliance.

703 DELINEATORS AND MARKERS

Posts are to be checked to maintain good alignment, proper orientation, and correct height. Do not allow driving that will damage the top of the post. When placed in hard or rocky ground it may be necessary to pre-drill a hole to the required depth. Cutting of posts because driving is difficult should never be allowed.

Faceplates are installed after the post is driven. Driving posts with the faceplate attached may cause the mounting bolts to shear. Sometimes the bolts do not shear completely and may not break off until after the project is accepted. Then ADOT maintenance has to remount the faceplate.

Guidelines for Inspecting Delineators and Object Markers:

- Do the following materials conform to the Project Plans and specifications and are material certifications available for those items requiring them?
    - Reflective Sheeting
    - Prismatic Reflectors
    - Metal Posts and Plates
    - Hardware
    - Paint
- Are steel posts driven with a driving head when soil conditions permit?
- Are posts plumb and properly aligned?
- Does the installation conform to the applicable Roadway Construction Standards?
- Are items that were inspected at the manufacturer's plant properly stamped

704 THERMOPLASTIC PAVEMENT MARKINGS

The materials used in thermoplastic may cause allergic reactions in some people, so it is recommended that persons working with or around thermoplastic material carefully monitor themselves and others for such reactions. Material Safety Data Sheets (MSDS) should be available from the Contractor describing the hazards of working around thermoplastic materials.

Spilled material and containers are to be cleaned up and disposed of quickly and correctly. The containers will have recommended disposal instructions printed on them if disposal is necessary.

Alignment of stripes should be checked, and any corrections in the application method should be made at the very beginning of the striping operation. Thermoplastic markings will be there a long time so they need to be placed correctly the first time.

Surface preparation is critically important for long-lasting thermoplastic markings. On concrete pavements, the areas to be marked need to be thoroughly cleaned (usually by water blasting or sandblasting) and free of all curing compounds (which acts like a bond breaker). Any oil or fuel spills on the pavement need to be removed before thermoplastics are placed. A primer-sealer must be applied to Portland cement concrete and existing asphaltic concrete surfaces before application of the thermoplastic material.

Additional items to be checked during thermoplastic striping include:

- Is the material on the current Approved Products List?
- Does the Certificate of Compliance conform to subsection 106.05, along with precertification test results from ADOT central lab?
- Check the expiration date; shelf life is less than one year.
- Is the application equipment within specification?
- Is the material temperature within the specified range when applied?
- Ensure the road surface temperature and wind chill factor stay above minimum.
- Is the pavement clean and dry?
- Is the material bonding to the pavement?
- Are the thickness and widths of the stripes per plan?
- Stripes are not to be applied over pavement joints.
- Is the correct amount of glass beads mixed into the molten material and firmly embedded to the thermoplastic surface?
- All white and yellow pavement marking materials shall have the prescribed minimum retro reflectance values when measured by the Department, as described in Subsection 704-3.02(G), within 30 days of application, but no sooner than three days after application to the roadway surface.

704-3.03 (B) Retro Reflectance Testing

The testing of thermoplastic markings for retro reflectance requires a technician to walk on the road in the direction of traffic, traffic control measures should be employed to ensure the safety of the technician and any other personnel involved in the testing operation, the use of law enforcement is recommended and encouraged when testing. Calibration of the LTL-X Delta retroreflectometer or similar device is done according to the manufacturer's requirements annually. It’s a good idea to have at least two technicians trained in each district to use this device. The ADOT Construction Group can assist by providing training if schedule permits. Retroreflectometer devices are housed in the ADOT Materials Group ANNEX and usage should be coordinated through the Material ANNEX Supervisor. A nighttime visual inspection should be conducted to identify any questionable areas and should be included in the testing area.

Additional points to keep in mind while testing for retro reflectance:

- Testing is performed every 0.2 miles, with the average of four readings taken at each location.

- The four readings are taken randomly within a 10 foot section and the average of the four readings is the result for the location.
- If the average of the readings does not meet the required retro reflectance values, a second test of four readings will be performed 50 feet forward from the failing test, the higher average test results of the two are used for that location.
- On roadways where yellow stripes separate opposing traffic, testing is done in both directions, two locations per 0.2 miles, one in each direction for each line.
- Lines less than 0.2 miles must be tested. A single test of four readings can be taken at the approximate midpoint of each line, if the average of these readings does not meet the required retro reflectance values, a second test of four readings has to be performed at the approximate halfway point between the midpoint and end of the line.
- Transverse markings, symbols or legends are not tested.

704-4 Method of Measurement

Gaps in dashed lines are deducted from the total length of striping. Double lines are measured as two individual lines. Striping that is wider or less than 4-inch must be converted to equivalent 4-inch striping in accordance with the Standard Specification.

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{\text{4 (inches)}}$$

Each legend and symbol is measured separately. A legend is defined as a complete letter grouping such as “RR”, “SCHOOL”, and “XING”. For example: “SCHOOL” “XING” are measured as two separate legends.

705 PREFORMED PLASTIC PAVEMENT MARKING

Preformed markings have a retro-reflective film coating on a backing that is coated with an adhesive capable of adhering to the roadway surface. Preformed pavement marking tape, arrows and legends come in four basic types depending upon use; Type I (Permanent), Type II (Temporary - Removable), Type III (Temporary - Nonremovable) and Type IV (Permanent). Type III (Temporary - Nonremovable) has a metal foil backing which makes it easy to identify. Type III should only be used for temporary markings on pavement surfaces that will be removed, or covered by additional paving during completion of the project. Type II (Temporary - Removable) is more expensive than Type III, but it can be removed manually. Type II can be used for temporary markings on final pavement surfaces. Type I (Permanent) looks similar to Type II. Type I is used for final markings in locations of high wear such as stop bars. Type IV is high durability and used in severe wear conditions with high traffic volumes. Certificates of Compliance are required for all types in accordance with subsection 106.05.

Preformed markings are factory or field cut to the specified shape and are applied with an adhesive. The adhesive may be pre-coated or applied separately. No matter how the adhesive is applied, it must allow the marking to be moved around before the final pressure is applied to seal it in place.

The pavement must be non-bleeding, clean, warm, and dry. The manufacturer's recommendations are to be followed and a copy of the recommendations should be included in the project file.

Temperature records and comments on how the pavement was cleaned and its condition at the time of application are to be included in the Inspector's diary.

706 RAISED PAVEMENT MARKERS

There are many different types of raised pavement markers. Most projects will use more than one type of marker in approximately the same location. The inspector must verify the correct type of marker is being installed at the correct location as shown on the plans. Inexperienced inspectors will find Signing and Marking Standard Drawing M-19 (sheets 1 through 3 of 9) very helpful when trying to identify the various types of markers. Certificates of Compliance are required for raised pavement markers. Raised markers are applied using the type of adhesive specified in the Project Plans, Special Provisions, or Standard Specifications. Standard Specifications require a hot-melt bituminous adhesive from an approved manufacturer. The inspector should verify the adhesive manufacturer is on the Department's current Approved Products List.

The surface to which the adhesive is applied must be dry, free of dirt, paint, curing compound, and any other deleterious materials which would adversely affect bonding of the marker to the surface. Loose layers of pavement must be corrected prior to application of adhesive. The method of cleaning detrimental material from the surface is subject to the approval of the Resident Engineer. The Resident Engineer and Inspector should ensure the cleaning method includes sweeping and high pressure air spray. On Portland cement concrete and old asphaltic concrete pavements, cleaning shall be accomplished by sandblasting followed by sweeping and air blowing. Clean, newly placed asphaltic concrete does not require sandblasting unless substantial contamination is evident.

706-3 Construction Requirements:

Adhesive must be applied uniformly and in accordance with directions from the manufacturer. This will include removing excess adhesive from the pavement and the markers themselves, and protecting the markers from impact until properly set.

Temperature, humidity, and surface moisture are important elements which should be monitored by project personnel. If these elements begin affecting the proper placement of the markers and do not meet the requirements of the manufacturer, it may be necessary to suspend work.

Inspection of raised or recessed pavement markers during installation should include verification of correct orientation. After several hundred markers are placed in a shift it can be easy for the installer to get a few backwards. A quick drive through the project can easily expose these markers to get them corrected.

707 TUBULAR MARKER (FLEXIBLE)

707-1 Description

Tubular Markers (Flexible) are most often utilized to provide warning or delineation of roadside hazards, including median curb islands and changes in roadway features. As the name suggests, these devices are meant to be flexible, so as to be able to take the impact of a vehicle in the event the driver misses corner entry.

707-3 Construction Requirements

With the preceding in mind, the Inspection team and contractor should be mindful to follow the installation details and make sure that the devices are indeed flexible if impacted by a passing vehicle. Tubular markers are most often surface-mounted to the roadway or median. The most common installation methods include bituminous material or post-installed concrete anchors. Installation details can be found in the Traffic Signing & Marking Standard Drawings, found on the ADOT Traffic Group webpage. Additionally, the manufacturer's recommendations shall be followed.

Layout and spacing details are covered under Standard Detail M-26. It is also important to follow the layout details for the tubular markers, making sure to adhere to the proper spacing requirements. While the Regional Traffic Engineer should be consulted by the design team during project development, the Resident Engineer should reach out to their RTE to confirm the marker layout and make any necessary adjustments that may be required.

708 WATERBORNE PAVEMENT MARKINGS

Waterborne pavement markings are typically the initial striping of all pavement remediation projects and are therefore quite important to the final striping configuration and aesthetic of a project. Section 925-3.01 provides the details regarding survey requirements for striping and the inspector should become familiar with what the final roadway will look like. This information is usually found in the project plans, however certain projects will rely on the contractor's striping as-built survey data to recreate the original layout.

Waterborne pavement markings are divided into 2 classifications - Type I (Standard), and Type II (High-build). Both classes can also be further divided into fast-dry or rapid-dry.

Type I (Standard) is used for long line and short line striping including symbols and legends and typically is used for the following:

- For temporary traffic control.
- At the end of a work shift if the roadway is to be opened to traffic.
- As a primer on the final lift or layer of pavement 30 days prior to the application of the durable pavement marking materials. This is a use case example. This does not mean that Waterborne Pavement Markings must cure for 30 days prior to final pavement markings.
- During construction on pavement that will not be resurfaced.

Type II (High-build) is also used for long line and short line striping including symbols and legends and is used for the following:

- For temporary traffic control.
- Needs to be in place and serviceable for at least 180 days.
- Used between two construction seasons.

Rapid-dry paint shall dry to a no-track condition in 60 seconds or less, fast-dry paint shall dry to a no-track condition in five minutes or less.

All waterborne pavement marking paint shall be on the Approved Product List, shall be precertified from the Central Lab, and shall have a Certificate of Compliance conforming to Subsection 106.05.

709 DUAL COMPONENT PAVEMENT MARKINGS

The importance of roadway striping can not be overemphasized. The final striping of any project on a new surface is what the public will see day or night, rain or shine, and needs to be clean and consistent.

It is very important prior to the start of striping operations that the locations for the final striping are laid out by survey. This will help ensure that striping lines and symbols are neat and clean and in the locations they need to be.

At least 2 weeks prior to application, a pre-activity meeting should be held with the contractor, contractor's surveyors, pavement marking subcontractor, and the Engineer to discuss survey control and layout for the striping. Survey control will be provided for the pavement marking subcontractor.

Survey points are to be set by instrument at intervals 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.

On projects with No Passing Zones, it is very important that the contractor coordinate the survey layout with ADOT's No Passing Zone Crew (phone number on project plans) at least 14 days before placement of pavement markings.

In most cases, the permanent paint striping will be placed in the final location of the dual component epoxy. However, if there is an error in the layout of the permanent striping, the best time to catch and correct it is prior to the placement of the dual component stripe.

Dual component pavement markings shall not be applied to new asphaltic concrete pavements, or bituminous treated surfaces, for a minimum of 30 days after the pavement has been placed.

On the day the dual component striping is to begin, the road surface shall be cleaned of all dirt, dust, grease, oil or other detrimental material by the contractor prior to application.

The roadway surface shall be dry with no surface dampness.

Surface temperatures at the time of application shall be 40 degrees F and rising. Air temperature and wind chill shall not be lower than 35 degrees F. It is best to discuss the weather forecast during the pre-activity meeting should concerns about low temperatures manifest themselves.

When striping on PCCP (Portland Cement Concrete Pavement): Any curing compound present is removed by means of a high-pressure water jet or sandblasting at least one inch beyond the width, followed by sweeping and high-pressure air spray.

Prior to the start of application of the dual component stripe, it is necessary to follow steps 1 through 4 of Section 709-3.02(F)(1) in the ADOT Standard Specifications to ensure that the striping equipment is properly calibrated.

The width of the striping is in accordance with the striping plan. (When plan stripe width is six (6) inches, actual width is 6 to 6 ½ inches; when plan stripe width is 8 inches, width is 8 to 9 inches; when plan stripe width is over 8 inches, width is plan width ± ONE inch).

For striping placed on AC, dual component markings shall be .025 ± 0.002 inches thick. Dual Components placed on PCCP shall be .020 ± 0.002 inches thick.

Glass beads are an important ingredient of dual component epoxy and it is necessary for ADOT to ensure that the glass bead delivery equipment is properly calibrated. This calibration is done daily prior to the start of epoxy striping. Section 709-3.02(F)(2) of the Standard Specifications has the steps needed to ensure equipment calibration is done properly.

Dual Component Pavement Markings: Contractor has provided documentation to the Engineer to verify that the driver and operator of the application truck are fully trained and experienced in the application of the dual component marking system.

Dual component pavement markings, whether longitudinal or transverse are measured by the linear foot along the centerline and are based on the 4-inch equivalent stripe and calculated from the formula below:

$$\frac{\text{Plans Width of Striping (inches)} \times \text{Linear Feet}}{\text{4 (inches)}}$$

Symbols and legends will be considered as a unit for purposes of measurement and payment.

Following completion of all dual component striping ADOT shall perform retroreflectivity testing. Each district has retroreflectivity testing equipment assigned to it, however, it may be required that advanced scheduling of this equipment be performed so that testing is completed within the time specified by the contract special provisions.

Testing shall be performed not later than 30 days, but no sooner than 3 days after striping is completed. Copies of the test results will be provided to the contractor.

Dual component striping that does not meet the minimum retroreflectivity as defined by the special provisions shall be re-striped and retested. In some cases it may not be practical to retest with a retroreflectometer. In such instances, the Department may perform visual nighttime inspections and if the re-striping appears as bright as the surrounding stripe, then the Engineer can accept the reapplication.

710 SMART WORK ZONE SYSTEMS

710-1 Description

One of ADOT's primary goals for any construction project is the safe and efficient handling of traffic through and around construction zones with as little inconvenience and delay as possible. The constant watchfulness by the Resident Engineer (RE) and all inspection personnel is necessary to accomplish this goal. The highest concern should always be the safety of the public, workers, and Inspectors. In the current environment of increasingly digital and virtually connected workspaces, traffic control has entered into this technological field with the development of Intelligent Transportation System (ITS) or Smart Work Zones (SWZ). In the simplest of terms, Smart Work Zones consist of data collection and data analysis which then delivers fully automated traffic information to all concerned motorists about real-time downstream traffic conditions. Smart Work Zones can be as small as two to five devices or scaled up to as large as the project may need. SWZs typically consist of four features:

1. **Detection and surveillance equipment** - Collects speeding and queuing data and video near the work zone and sends data to the central processing system.
2. **Central processing system** - Analyzes, processes and stores the data.
    - Received from the SWZ devices deployed and third-party subsystems.
    - The central processing system also pushes messages to the public through message signs.
3. **Dissemination outlets** on and off the road that interpret real-time information about work-zone conditions available to the public and governmental agencies.
4. **Auxiliary equipment** that provides communications, safety protocols, geolocation, power supply, portable trailers, and static traffic control devices required to achieve a fully functional SWZ system.
    - Auxiliary equipment is considered included.
    - Various miscellaneous components to the SWZ devices and systems required for a functioning system are also included.

710-1.01 Abbreviations

AFADs	Automated Flagger Assistance Devices
AVL	Automated Vehicle Locator
CCTV	Closed-Circuit Television
CMB	Changeable Message Board
CoA	Certificate of Analysis
CoC	Certificate of Compliance
CSA	Communications Site Assessment
DAS	Digital Alert System
DMS	Dynamic Message Sign
DLMS	Dynamic Lane Merge Subsystem
FMS	Freeway Management System
GPS	Global Positioning System
GPSLS	Global Positioning System Location Sensor

GUI	Graphical User Interface
IDS	Impact Detection System
O&M	Operations and Maintenance
OMP	Operations Maintenance Plan
PDA	Power Distribution Assembly
POC	Point of Contact
PTS	Portable Traffic Signal
PTZ	Pan, Tilt, and Zoom
QWS	Queue Warning Subsystem
SAB	Smart Arrow Board
SCP	System Configuration Plan
SFS	Speed Feedback Sign, a.k.a. Speed Feedback Board
SWZ	Smart Work Zone
TCP	Traffic Control Plan
TDC	Traffic Data Collection
TDCS	Traffic Data Collection Subsystem
TEES	Truck Entry/Exit Subsystem
TMA	Truck-Mounted Attenuator
TMCS	Traffic Monitoring Camera Subsystem
TOC	Traffic Operations Center
TOM	Transportation Operational Monitoring
TOM-POC	Transportation Operational Monitoring – Point of Contact
TPRS	Temporary Portable Rumble Strips
TTS	Travel Time Subsystem
VPDL	Vehicle Presence Detector Location
VSDL	Vehicle Speed Detector Location
VSL	Variable Speed Limit
VSLS	Variable Speed Limit Sign

WZDx Work Zone Data Exchange

710-1.02 Definitions

SWZ System:

The SWZ system is a broad range of portable communications-based information and electronic technologies placed in and around work zones to enhance transportation and improve safety and mobility. The real-time information and automation provided by the SWZ system is used by contractors and transportation agencies to alter traffic control strategies, provide traveler information to better inform motorists of upcoming traffic conditions, allow motorists the opportunity to alter their travel routes, and/or modify the travel behavior within work zones. The SWZ system consists of one or multiple SWZ subsystems that operate together.

SWZ Area:

The SWZ area is the area where SWZ field devices are deployed near, within, and/or around the project and work zone limits.

Active Work Space:

The active work space is the area that is anticipated to have the largest concentration of field personnel within the work zone during a specific day or construction shift. The personnel working in active work space are exposed to the dangers of an errant vehicle.

Work Zone:

The work zone is the entire area in which traffic control devices, which includes static signs and SWZ field devices are implemented. This includes the area approaching and the active work space.

Traffic Data Collection Subsystem (TDCS):

The TDCS is a component of the SWZ system that is capable of detecting, processing, and disseminating real-time traffic information such as vehicle speeds, traffic volumes, and travel time/delay within and in advance of the work zone for use by other SWZ subsystems, third-party traveler information systems, and/or to archive work zone traffic conditions. This subsystem could also include the use of third-party data, solely, or in combination with site specific gathered data.

Vehicle Speed Detector Location (VSDL):

A VSDL functions like the TDCS, but only collects vehicle speed data for use by other SWZ subsystems, third-party traveler information systems, and/or to archive work zone traffic conditions.

Vehicle Presence Detector Location (VPDL):

A VPDL functions like the TDCS but only collects vehicle presence data for use by other SWZ subsystems, third-party traveler information systems, and/or to archive work zone traffic conditions.

Queue Warning Subsystem (QWS):

The QWS is a component of the SWZ system that uses the real-time TDCS information to determine traffic queue lengths. The QWS warns approaching travelers of slowed or stopped traffic conditions through warning messages displayed on SWZ CMBs. When a queue begins to form, the QWS automates the display of warning messages on the associated SWZ CMB displays located in advance of the anticipated queue areas. The QWS also alerts field personnel and remote SWZ system operators of the real-time queue conditions.

Hybrid Queue Management Subsystem:

A subsystem that performs both queue warning and dynamic lane merge functions at the same time.

Dynamic Lane Merge Subsystem (DLMS):

The DLMS is a component of the SWZ system that uses the real-time TDCS information and SWZ CMBs, in advance of a lane closure, to instruct approaching travelers when to merge. When traffic volumes are high or a potential queue condition is detected by the DLMS, the DLMS automates the display of messages that instruct drivers to merge later. When traffic volumes are low and a potential queue condition is not detected in advance of the lane closure, the DLMS automates the display of messages that instruct drivers to merge earlier.

Travel Time Subsystem (TTS):

The TTS is a component of the SWZ system that uses the real-time TDCS information and SWZ CMBs, in advance of the work zone, to determine the approximate travel time between the SWZ CMB location and another fixed point as shown on the project plans, or at the end of the work zone. The TTS automates the display of messages on each CMB to inform the drivers of the associated travel time (at predetermined locations) through the work zone. In addition, the TTS can be configured to compare real-time TDCS information to historical travel time information to estimate the approximate travel delay that a driver can expect, when traveling through the work zone.

Traffic Monitoring Camera Subsystem (TMCS):

The TMCS is a component of the SWZ system that uses closed-circuit television (CCTV) cameras to provide real-time video streams that are monitored on-site by field personnel using a mobile display device and/or remotely by the Engineer, TOC operators, and the District to view real-time roadway traffic conditions within the work zone.

Variable Speed Limit (VSL) Subsystem:

The VSL subsystem is a component of the SWZ system that uses TDCS real-time traffic information and VSLS to dynamically reduce or increase regulatory speed limits in the work zone. Regulatory speed limits are dynamically reduced in the active work space. Regulatory speed limits are dynamically increased within the same area of the work zone when the construction personnel are not present.

Truck Entry/Exit Subsystem (TEES):

The TEES is a component of the SWZ system that uses the real-time TDCS information to determine the entry of construction vehicles to the roadway from the work area and warns approaching travelers of slow-moving vehicles ahead. The TEES may warn drivers by displaying a message on a SWZ CMB or by illuminating flashing warning lights attached to a static sign. Once the construction vehicle has entered the roadway and a predetermined amount of time has passed, the TEES no longer displays the warning message until it detects another construction vehicle entering the roadway from the work area. The TEES also alerts the field personnel and remote SWZ system operators when the system is activated.

Digital Alert System (DAS):

The DAS is a component of the SWZ system that collects digital alerts from AVL devices deployed, within DLMS, IDS, QWS, TEES, TTS, VSL, and subsystems, and distributes the digital alerts to third-party navigation systems, e.g. Waze, Apple Maps,Google Maps and connected in-car safety alert systems, e.g. Jeep, Dodge, RAM, Chrysler, Alfa Romeo. The DAS software platform can receive, store, analyze, send, and display real-time location information of construction vehicles and SWZ field devices to alert the traveling public of the work zone location along with related work zone activities, e.g. lane closure, traffic queuing and delay.

Automated Vehicle Locator (AVL):

The AVL is a component of the SWZ system that tracks the location of active vehicles, e.g. portable impact attenuators and active SWZ devices, e.g. arrow boards marking the start of a lane closure. The AVL sends this location date, along with the type of vehicle or device, to the DAS for processing and distribution to third parties.

Impact Detection System (IDS):

The IDS is a component of the SWZ system that uses electronic devices that monitor for impact when attached to guardrails, work zone attenuators, permanently installed crash cushions, cable barriers, truck mounted attenuators, end terminals, or other critical safety roadway assets. The electronic devices deployed in the project area incorporate both impact sensors and communications technology to send impact alerts to a remote system server that processes the alerts and notifies personnel, via smartphone text message or email, when a protection device is struck by a vehicle.

Transportation Operational Monitoring (TOM):

The TOM program requires a designated TOM-POC responsible for analyzing data being received from the SWZ devices to measure, identify, and report on operational issues due to MOT lane restrictions, capacity modifications, road closures, and detours. The TOM-POC coordinates with the project stakeholder, e.g. ADOT, MOT team, Public Information team, and regional stakeholders responsible for traffic operations along detour routes on arterial roadways, to implement congestion mitigation strategies within the work zone and along detour routes and to respond to operational inquiries.

Smart Temporary Portable Rumble Strips (TPRS):

The TPRS alerts distracted drivers in work zones and other changing road conditions. The Smart TPRS is a component of the SWZ system that includes a TPRS assembly with an integrated GPS location device and communications device used to push the GPS location data and type of device, e.g. Smart TPRS, to the SWZ system.

Automated Flagger Assistance Devices (AFADs) Subsystem:

The AFADs is a portable flagging station that removes the traditional human flagger from the road while providing motorists with clear guidance through a TTC zone.

SWZ System Software:

The SWZ system software is a software platform that can receive, store, analyze, send, and display real-time information from the TDCS, QWS, DLMS, TTS, TMCS, TEES and VSL subsystem field devices, Department furnished data from roadway sensors, or other third-party sources. The SWZ system software provides the required automation, GUI, user device applications, and system reports required to operate and maintain each respective SWZ subsystem deployed within the SWZ area.

710-2 Materials (Equipment, Workers, Devices and Facilities):

710-2.01 General Requirements

As with any traffic control deployed onto a construction project, an approved TCP has to be submitted by the contractor for review and approval by the Engineer. SWZs are no exception and have a much higher degree of documentation required for acceptance.

These include:

- CoC for all devices planned to be used, must conform to Subsection 106.05.
- SWZ Technician Credentials, proof of technicians qualifications to deploy and maintain chosen devices.

- CSA proof that the chosen communications will work in the area.
- SCP shows where devices will be placed, operational logic used for each subsystem, what alerts are generated and where they are sent.
- SWZ Systems and OMP describe how the system will be maintained, adjusted or repaired.
- SWZ Software User Training Outline and Schedule, contractor provided training for field and Department staff.
- SWZ Software User Access Privileges and Alert Messages, coordinated details between the contractor and the Department defining user access levels to the system and who will receive alerts generated by the system.
- SWZ System Data Reports examples of the system generated reports to be sent weekly to the Department.
- Subsystem Acceptance Testing Procedures logs for all devices to be used in their planned locations.
- CoA for all devices planned to be used, must conform to Subsection 106.05.

Once a submitted TCP has been approved for use, the Inspector should have a copy of all of the above records and verify in the field for their accuracy and document these details and the location of in-use devices in their Daily Dairy.

An item that will be very insightful for the Engineer and field inspection staff is to make full use of the contractor provided training. What was deployed last year may not be what will need inspection this year.

710-2.10 Data Submittal

The SWZ system software shall record all alerts related to any loss of communications, instances of low power, and loss of power for the project duration.

The SWZ system software vendor shall also record the following data before final project acceptance:

- All real-time traffic information received by the SWZ system software from all TDC locations deployed in the SWZ area and received by third-party sources, and all real-time traffic information generated by the SWZ system software within every one-minute time interval.
- All messages posted on all SWZ CMB assemblies deployed in the SWZ area.
- All speed limits on all VSLS assemblies deployed in the SWZ area.
- All geolocation data associated with these devices and the required device data.
- A date and time stamp that the data pertains to each data set.

This data shall be submitted electronically to the Engineer in a format compatible with the Work Zone Data Exchange Common Core Data Specification version available at the time of the project’s bid opening date.

710-4 Method of Measurement / Basis of Payment

SWZ system will be measured on a lump sum basis for a fully functional complete in place system. Individual items will be paid under their respective bid items. The inspector will need to review each project's Special Provisions to determine the correct method of payment and be aware that some items are paid through the weekly MPT report, while others are paid daily on the items tab in the Daily Diary.

730 GENERAL REQUIREMENTS FOR TRAFFIC SIGNAL AND HIGHWAY LIGHTING SYSTEMS

Traffic signals, highway lighting, and highway electrical systems are integral parts of roadway design and construction. Attention to electrical inspection and quality control can eliminate costly corrective measures and frequent maintenance costs after completion of the work. Once the hardware and equipment have been installed, many of the installation details will not be visible. The only evidence of incorrect procedures may be decreased reliability during the operation of the system. It is extremely important that the Resident Engineer has trained and skilled Electrical Inspectors assigned to inspect the electrical portions of the contract.

Regional Traffic Signal/Lighting outside of Central District may provide the Electrical Inspector for the project. Within the Central District the VISION Field Office may provide this inspector. A consultant may also be used through the temp-tech contract. This Inspector will act as a technical advisor to the Resident Engineer during the phase of the project that deals with traffic signals, highway lighting, and electrical devices. The Inspector will report directly to the Resident Engineer unless other lines of responsibility have been prescribed by the Resident Engineer. When an Electrical Inspector is assigned to a construction project, he or she will be primarily responsible for the inspection of electrical systems to ensure compliance with the contract documents, codes, and regulations governing the installation and operation of electrical systems.

The Electrical Inspector's work begins as soon as the final construction plans are received. A copy of the Project Plans should be forwarded to the Electrical Inspector for the project, who should carefully review the Project Plans and inform the Resident Engineer of any discrepancies or omissions that are evident. Such a thorough review can avoid costly change orders or potential claims. During construction, the Electrical Inspector will check certifications, perform all inspections related to electrical items, and submit the proper documentation on all electrical pay items as directed by the Resident Engineer.

Traffic Signal Activation and Final Cleanup

Before the Inspector can recommend activating and accepting any traffic signals or other electrical work, he or she should be satisfied that all required work is completed. The following inspection guidelines should be reviewed in order to provide the Inspector with an accurate appraisal of the work performed:

- Were signal circuits tested with 120-volt power applied to each signal wire at the pull box and in front of the control cabinet by the Contractor in the presence of the Inspector?
- Has the Inspector coordinated the activation date with the Electrical Inspection Supervisor, Traffic Group, who in turn will schedule the Department or local agency's technician to connect the field wire inside the control cabinet and set up the timing of the controller and activation?
- Is the roadway striping and signing done or coordinated with the District for the same day of activation?
- Has the Contractor arranged for traffic control for the day of the activation?
- Does the Contractor have sufficient personnel and equipment for the activation?
- Were stop signs removed after the signal was activated?
- Are signal heads aimed for proper alignment?
- Is all grouting completed?
- Is all touch-up painting completed?
- Was all patching or replacement of AC or PCC completed?
- Did the Contractor clean up and remove all construction rubbish and equipment from the highway right-of-way?
- Was existing landscaping and grading restored to the original or an acceptable condition?
- Were all final measurements and quantities recorded and submitted to the Resident Engineer?
- Were as-built plans completed and submitted?
- Was salvaged equipment dismantled and stockpiled or delivered?
- Was any salvage equipment that was damaged or destroyed by the Contractor replaced?
- If the Department or local agency loaned equipment or material to the Contractor, was it returned?

- Did the Contractor furnish and deliver to the project office all manufacturer's warranties and guarantees?

730-4 Equipment List and Drawings

The specifications require that the Contractor submit a complete project material for approval to the Engineer electronically by the pre-construction conference. In addition to the electronic submission, the Engineer may request up to three hard copies. This list shall contain all required information listed in the Project Plans and Special Provisions and shall be reviewed and approved prior to ordering materials. The Contractor should be notified of the review time requirements and the possibility that it may be necessary for some items to be resubmitted.

Shop drawings for signal and lighting equipment are required and must be submitted for review and approval before ordering this equipment. These shop drawings must include all pertinent information related to providing a fully functional system. Such information may include photometric data sheets, optical details, and wiring diagrams.

730-7 Installation of Decals

The specification requires that the contractor shall furnish and install a maintenance unit number decal approximately 42 inches above the base-plate displayed on the traffic-side of the device at a 45 degree angle to the direction of travel, or as approved by the Engineer.

731 STRUCTURAL SUPPORTS AND FOUNDATIONS FOR TRAFFIC SIGNAL AND HIGHWAY LIGHTING

To ensure traffic signal and lighting systems perform as designed and provide the required life as expected, it is very important that project personnel closely monitor the installation of foundations and structural supports.

The Inspector should be familiar with those specifications that apply to proper excavation, placement of concrete, and backfill requirements when applicable. The Inspector must ensure that all excavations and construction of foundations are coordinated in order to minimize the time of open trenches or excavations. Those excavations that are open and not complete must be covered and properly barricaded to protect the workers and the public.

Construction and Inspection Requirements

The following guidelines are intended to assist the Inspector in providing a complete and thorough inspection of foundations and supports on the project:

Foundations

Locations for foundations will generally be laid out by station numbers, offsets, and elevations by the Contractor's survey crew.

- Check consistency of survey layout and plans. If in doubt, have the survey crew recheck.
- Are locations of underground utilities blue staked?
- Have overhead utilities, high voltage electric lines, and overhangs been checked for clearance?
- If a pole foundation cannot be installed at the location designated due to obstructions, they may be moved as directed by the Resident Engineer. If a foundation location is moved, it is critical to verify that the mast arm length specified will still meet the placement criteria.
- Check sides and bottoms of augured holes for firm and stable soil conditions.
- Did it require a deeper foundation for unstable soil and/or steeper slope?
- Are foundation holes the proper size?
- Was any irrigation conduit rerouted on foundations? (rule of thumb 4').
- Are forms and templates securely braced?
- Check anchor bolts and conduit stubs for proper size, alignment, position, and height projections.
- Is there a 25-foot coil of #4 AWG copper ground wire placed at the bottom of the pole foundation hole and a 1-inch sleeve for a 5/8-inch by 10-foot ground rod in the cabinet foundation?
- Make sure that utilities like water, sewer, and telephone lines are not encased in foundation holes.
- Check steel wire cages for sizes and dimensions.
- When placing steel wire cages, spot check spacing and elevation for clearance compliance.
- Check steel wire cages for loose rust and scale.
- Have all certificates been received and submitted to the project field office for anchor bolts and steel wire cages?
- Has the concrete design mix, source, and curing compound been approved?
- Does the Contractor have a vibrator and tremie at the project site?
- Was the poured concrete vibrated regularly by the Contractor in presence of the inspector?
- Have the sides and bottom of the foundation hole been thoroughly moistened prior to placing concrete?
- Check to see that surface finish on concrete is as specified.
- Make certain on all types of cabinet foundations that there are two 2-inch conduit stubs for future use. The conduit should be stubbed out and capped 2 feet past the edge of foundation and noted on the as-built plans.
- Was there a PCC pad poured in front of all cabinets in unpaved areas?
- Have batch tickets for each load been received and submitted to the project office along with the required quantities report?

- Was a ground resistance test performed and recorded in the presence of the Electrical Inspector on each foundation ground.
- Was the result of the ground resistance test 25 ohms or less?
- Have all changes been noted on the as-built plans?

Pole and Mast Arm Installation

All pole foundations must cure for three days prior to pole installation except for the Type J, K, Q, and R pole foundations (which must cure for seven days).

- Were poles and mast arms inspected upon delivery to the job site for conformity with the approved material list and shop drawings?
- Were certificates of compliance furnished upon delivery?
- Was the galvanized finish damaged in shipment, if applicable?
- Check coloring of galvanizing for uniformity if applicable.
- Check to see if a metal information tag is permanently affixed by the manufacturer to all poles and mast arms at the time of delivery to the job site.
- Upon delivery and prior to installation, inspection is needed for the inside of the pole for metal overrun (sharp edges from manufacturing process).
- Before poles are erected, make sure that there are no high voltage overhead electric lines any closer than 10 feet. If closer, has the Contractor made arrangements with the servicing utility company to de-energize or rubber-over to protect the workers from injury from the conflicting power lines?
- Were high strength bolts A325 used to connect the mast arm to pole?
- Were poles plumbed to the vertical with all mast arms, signal heads, and/or luminaries installed?
- Has the non-shrink, non-metallic grout used between pole base and foundation been approved?
- Check the block out area between pole base and foundation for complete grout fill.
- Make sure, for slip-away foundation base plates, that conduit entering into the plate is 1 inch below top of the plate.
- Check clearance of anchor bolts on slip-away foundation base plates. Is it 1/8 inch below the top of the plate?
- Did the measurement of the anchor bolt threads meet the 1'' (Typ) from the top of the anchor bolt nut to the end of the threads?
- Was there a 28 gauge galvanized steel keeper plate installed on slip-away poles between the slip plates?
- Were high strength connecting bolts on slip-away bases torqued to 208 ft•lb. in the presence of an Inspector?

732 ELECTRICAL UNDERGROUND MATERIAL

The Project Plans and specifications will specify the type of materials to be used and the location of conduit runs, junction boxes, and stations and offsets of pull boxes. The locations may be changed by the Resident Engineer to avoid conflicts with utilities and other underground obstructions. These changes must be documented and shown on the as-built plans.

The Inspector on the project must verify that the Contractor complies with any applicable national codes and contract requirements when installing conduit, conductors, pull boxes, and other related work. The specifications provide specific requirements that must be met for all work and materials provided.

The following procedure is a guide which should be followed by the Inspector to assure proper compliance with contract documents. The initial requirement of the contract is to blue stake any areas to be excavated prior to excavating. The Contractor must update the blue staking as required because the markings are valid for only fifteen working days.

Construction and Inspection Requirements

Conduit Installation:

- Has the Inspector sent samples of all sizes of conduit to ADOT Materials Group for testing prior to installation?
- Check to see if PVC conduit has the UL approval stamp, the manufacturer's name, trade size, schedule 40, and 90 degree temperature rating imprinted on each 10-foot length of conduit.
- Was the conduit inspected for cracks, gouches, elongation and sunburn before installation?
- Is conduit embedded in concrete structures securely tied to reinforcing steel every 12 inches?
- Check expansion fittings. Are they installed properly where conduit crossed expansion joints in the structure?
- Open trench installation of conduit should be checked for straight line, grade level, and depths.
- Is back-fill material clean and granular type, and compacted in accordance with the specifications?
- If trenches remain open overnight, a minimum of 6 inches of back-fill material should be used as a protective cover to eliminate the contraction of conduit. Backfill material shall be removed if final inspection has not been made.
- Is warning tape installed in open trenches at a depth of 6 to 8 inches above the highest conduit?
- Make sure trenches left open overnight are properly barricaded.
- See that no open trenching across an existing roadway is performed without written authorization from the Resident Engineer.
- For conduit that is designated as "future use," check to see that a #8 bare bond wire is installed and that the conduit is properly capped, plugged or sealed with conduit putty.
- Make certain that the Contractor has cut a 3-inch "Y" into the face of the curb directly over the conduit located under the curb line.
- Has the Contractor blown out, with compressed air and mandrel all existing conduits incorporated into the new system?
- When conduits enter pull boxes, are they located near the sides and 2 to 4 inches above the bottom of the pull box while sloping towards the direction of the conduit run?
- Check conduit ends in pull boxes and foundation. Do not allow the Contractor to pull the conductor until all end bells are installed on conduit ends.
- Are jacking (boring) and drilling pits no closer than 2 feet from the edge of the travel pavement and barricaded?
- Has the Contractor documented and properly noted all conduit changes on the as-built plans?
- Has the Inspector recorded all quantities on the proper forms and submitted them in a timely manner?

Electrical Conductors, Splicing, and Tagging:

Wire and cable for traffic signals, highway lighting, and other electrical systems shall be UL listed copper and rated for 600 volt operation.

- Were conduit bell ends installed on all conduit ends before wire was pulled?
- Did the Contractor clean out all of the conduit runs with a mandrel and compressed air before conductors were pulled?
- Was the UL label affixed to each reel, coil, or container of wire or cable delivered to the job site?
- Check to see if wire has distinctive and permanent markings showing the manufacturer's name or trademark, insulation type, size, UL and voltage rating.
- Double check plans conductor schedule for the number of conductors, size, and color-coding for each conduit run.
- Was an approved pulling lubricant used?
- Make sure wire is not dragged along the pavement or earth to avoid damage to the insulation.
- Is there a minimum of 36 inches of slack wire from the conduit end bell in the pull boxes?
- Were the detector lead-in cables pulled continuously and not spliced from the detector pull box to the control cabinet?
- Were cabinets, pedestals, poles and conduit and cable sheaths wear bonded to form a continuous grounded system?
- Were separate signal circuit wires installed to each mast arm mounted signal head from the pull box?
- Were all conductors tagged to identify their circuit number and function?
- Was tag identification correlated with the conductor schedule shown on the Project Plans?
- Was each signal wire tagged in pull boxes, in the terminal compartment of mounting assemblies, and in the control cabinet?
- Were signal conductors phase grouped together and tied in the pull box?
- Check roadway lighting conductors for circuit number tagging in pull boxes and service cabinets.
- Were in-line nonlocking type fuse connectors installed in the pull box for luminaries?
- Check fuse fault current rating and amperage rating.
- Was wire splicing done only in pull boxes, terminal compartments, and cabinets?
- Did the insulation of the splices consist of two layers of electrical rubber tape, four layers of plastic electrical tape, and two layers of friction tape?
- Were the tape splices covered with three coats of approved liquid waterproof splicing compound?
- Did the insulation tapes were securely applied over the bare wire splice area and back onto the original insulation a minimum of 1 inch?
- Check loop wire soldering splices.
- Check to see if heat shrink encapsulating fit caps were used to weatherproof the soldered loop splice.
- When the conductor schedule calls out for a green insulated copper bond wire, check to see if the insulation was removed from the bond wire in the pull box at the point where the wire leaves the end bell of the conduit?

Precast Reinforced Concrete Pull Box Installation:

- Check the size of pull boxes specified on the Project Plans.
- Ensure that the pull-box lid has proper ADOT legend.
- Reject chipped or cracked pull boxes, extensions, and covers.
- Check rock sump for depth and size of aggregate and backfill material.
- Was 30-pound felt paper used between aggregate and backfill material?
- Are pull boxes set at grade elevation and level with curb or sidewalk? In cut and fill areas, are the pull boxes at the same level as the slope?
- Check pull boxes installed in concrete areas for expansion joint material around the pull box.
- Check pull boxes installed to be free of debris.
- Are there four concrete blocks set under the pull box?

- Were any pull boxes relocated and as-built due to utility conflicts?

733 SIGNAL INDICATIONS AND MOUNTING ASSEMBLIES

Equipment compatibility is very important. All equipment at an intersection is required to be from the same manufacturer and of the same material. Maintenance or replacement costs are minimized by this requirement.

The Special Provisions or Project Plans will provide details and description of acceptable equipment and materials to be used on the project. It is important that the required shop drawings and materials list comply with the contract documents and show the specified material to be furnished.

Installation Procedures:

- Check the signal hardware package when it is delivered to the project site for conformity with the approved materials list, Standard Drawings, and project specifications.
- Do the traffic signal faces meet the optical requirements?
- Has the accuracy of pole layout for mounting assemblies been checked for correct orientation against the pole schedule and the Standard Drawings?
- Were the mounting bolts properly sized, galvanized steel bolts, 13-UNC with one flat washer and one lock washer?
- Check pipe nipple lengths on mounting assemblies.
- Were elevator plumbizers and pole plates checked to verify they were made of bronze?
- Check for double nutting on the through bolt for elevator plumbizers.
- Are all mounting assemblies plumbed and securely assembled?
- Are the arrow signal face lenses made of glass?
- Are the tunnel visors at least 11 inches in length?
- Check back plate dimensions.
- Were the correct wattage and type signal lamps installed?
- Check back plate for no open gap between elevator plumbizer and signal face section.
- When fiber optic turn-arrows are installed, check the post and side mounts to verify the individual lens holders are mounted perpendicular to the signal face. On mast arm mounts, they should have a 10-degree down angle.
- Were new not-in-service signal heads covered with burlap?
- Did the contractor level and square the traffic signal heads?
- Do the traffic signal heads align with the respective traveling lane?

734 TRAFFIC CONTROLLER ASSEMBLY

The traffic control assembly which includes the controller unit, auxiliary equipment, controller cabinet, foundation, conduit, anchor bolts, and clearance pad must conform to the requirements of the Project Plans and specifications. The unit must be fully inspected and accepted by the Electrical Inspector before incorporation into the project. The Contractor's material proposal shall include all required documentation related to the controller assembly. The specifications provide a list of the required documentation.

All traffic signal controller units require testing and pre-approval by the Department. The Contractor must deliver a complete controller assembly to the Department for testing. In the event the project falls under a local government jurisdiction, the unit should be delivered to that local government's traffic operations facility for their testing and approval.

734-2 Materials

734-2.03 Control Cabinets

The traffic control cabinets listed in the Project Plans and in the specifications are used to house pretimed and actuated signal controller assemblies. This includes intersection and auxiliary control cabinets. Housings must be NEMA approved, Type 3, weather resistant, and properly painted to meet specification requirements. The cabinets should be manufactured to meet the specific requirements of the plan details or specifications including the standard security measures. The specifications provide a list of individual components that should be considered as part of the cabinets and the Inspector should be satisfied that these are being furnished complete-in-place.

734-3 Construction Requirements

It is the responsibility of the Inspector to ensure that the Contractor installs all equipment according to the Project Plans, Special Provisions, and the Standard Specifications. This includes the correct wiring of all equipment, labeling of wiring, furnishing wiring diagrams, signal phase layout, and any other incidental work called for in the contract documents.

On construction projects involving intergovernmental agreements, the Inspector may have to coordinate his efforts with representatives of the local jurisdiction and obtain their approval prior to accepting any portion of the work as being complete.

Construction and Inspection Requirements:

- Were signal control cabinets and equipment delivered to the Department ADOT Traffic Operations) or local government agency's facility for testing approval?
- Was a 5/8-inch by 10-foot ground rod installed through the 1-inch sleeve in the foundation before the cabinet was set?
- Was the bottom of the cabinet sealed between the cabinet and foundation with a good quality caulk?
- Was the photocell oriented to the north?
- Service load center cabinets and service entrance equipment will be checked by the Electrical Inspector to verify:
    - Were all cabinets checked for conformity with the approved shop drawing and/or Standard Drawing?
    - Were all components in a 240/480 volt circuit rated for 600 volt operation and all other components rated for 250 volt operation?
    - Did the inspector submit the letter in-lieu of electrical clearance to the Electrical Utility Company for APS, SRP or GRIC? For other power companies was the green tag inspection completed?
    - Did the Contractor consult with the utility company to establish and install the proper amperage interruption capacity breaker?

- Was the meter socket approved by the utility company?
- Did the Contractor and Inspector meet with the utility company in the field to verify the exact location of the service run?
- Were all live electrical components protected by a dead-front panel?
- Were all circuit breakers labeled for the correct circuit number?
- Is there a wiring diagram placed in the cabinet?
- Did the Inspector approve all equipment and wiring before the Contractor contacted the utility company for hook-up?
- Was a ground resistance test performed and recorded in the presence of the Electrical Inspector on each ground rod at the service entrance equipment before being energized?
- Was the ground resistance test reading 25 ohms or less?
- If the ground resistance test reading was over 25 ohms, were additional ground rods installed and retested to achieve proper grounding below 25 ohms?
- After the electrical service was energized, was a voltage and amperage reading taken on each circuit?
- Were padlocks furnished and installed? Have plans been made for key transfer?

735 DETECTORS

Detectors should be installed as shown in the Project Plans. There are several different types of loops covered in this specification; signal loops for detection, preformed loop detectors, traffic data loops, WIM and pedestrian detectors. It may be necessary for the Resident Engineer to layout the exact locations of these detectors when the Project Plans are in conflict with existing detectors. It is important that the Resident Engineer contact the Designers if such a conflict is evident. The Electrical Inspector should bring any potential conflict to the attention of the Resident Engineer as soon as possible. Although the Inspector should make recommendations, no action should be taken until directed by the Resident Engineer.

Following installation of loop detectors, the Inspector should be satisfied that all required testing has been completed and the system is fully functional before accepting the work.

Loop Detector Installation:

- Check Project Plans for location, size, and type of loop detectors required.
- Make sure that loop detectors are installed in PCCP or Asphalt on new roadway construction.
    - Make sure loop detectors are properly located with respect to centering in each traffic lane and distance into the stop bar area (usually 6 feet if not specified).
    - Check the number of wire turns.
    - Was a 3/8'' High Temp Backer Rod installed continuous on top of the last installed loop wire?
    - Did the contractor twist the home run wire pairs 3 twists per foot?
    - Was the insulation resistance to ground test at least 50 megohms before and after the saw cut sealant was installed, and was it tested in your presence?
    - Did the Contractor perform and document a continuity test?
    - Were loop detector wires identified as to phase number, direction, and lane, with wire marking tags?
- Saw cutting loop detectors in asphaltic concrete or PCCP:
    - On new construction with multiple lifts of asphaltic concrete, make sure loop detectors are installed prior to the final lift being placed.
    - If a manhole or water valve cover is located where loop detectors are to be installed, the loop detector must be modified. Contact the project traffic Designer for a design change.
    - Are corner holes drilled first?
    - Is the saw cutting straight?
    - Check saw cut depth every 3 feet.
    - Were the saw cuts blown out with compressed air and dried before installing conductors? Check for small rocks and other debris.
    - Has the loop detector wire been approved?
    - Check the number of wire turns.
    - Were hold down tabs installed every 2 feet?
    - Was the approved sealant furnished and applied?
    - Was the insulation resistance to ground test at least 50 megohms before and after the saw cut sealant was installed, and was it tested in your presence?
    - Did the Contractor perform and document a continuity test?
    - Check sealant for voids.
    - Make certain that the Contractor has cut a 3-inch "Y" into the face of the curb directly over the loop detector conduit stub-out located under the curb.
    - Were loop detector wires identified as to phase number, direction, and lane, with permanent wire marking tags?
    - When loop detectors are to be installed on existing roadways under traffic conditions, does the Contractor have an approved traffic control plan?
    - The trap length will need to be tested and calibrated. The trap length is set with a test vehicle and adjustments in the controller.

- Were there any loops locations changed from the original plans and were they added to the as-builts?
- Was a loop detector accuracy verification form filled out?

A copy of the contractor's preliminary test results shall be furnished by the Engineer to the Data Section of the Transportation Planning Division (206 S. 17th Ave., MD 070R, Phoenix, AZ 85007) to allow for final TPD-Data testing and input of the detector into the state highway log. Prompt notification will allow for final inspection by TPD-Data Section prior to retention release. Look at the other type of loops. See the Construction Manual Forms tab on the ADOT website for "Detection Loop for Traffic Counter or ATR" form.

Refer to T.S. 6-1 through 6-8 of the ADOT 2012 Standard Drawings for Traffic Signals and Lighting on specific details of the type C, SA and SB traffic counter systems.

Refer to T.S. 7-1 through 7-5 of the ADOT 2012 Standard Drawings for Traffic Signals and Lighting on specific details of the Traffic Signal vehicle detection loops including preformed loops installed under PCCP.

736 HIGHWAY LIGHTING

Highway lighting materials including luminaires, lamps, fixtures, and all other components listed in the specifications should be inspected to make sure that they are in compliance with the Project Plans and specifications. The Inspector should be fully involved in the installation of the poles and any adjustment of the luminaires in order to assure proper initial installation.

In the event the construction involves an existing system, the system must remain fully functional at night for the duration of construction unless otherwise stated in the Project Plans.

Installation:

Highway Lighting luminaires are Light Emitting Diodes (LED) used for roadway lighting. These are horizontally mounted, vertically mounted, and high-mast mounted. The following guidelines should be followed by the Inspectors monitoring this work:

- Did the certificate of compliance meet the luminaire housing, electrical, optical, and LED performance requirements?
- Check all luminaries delivered to the job site from the approved materials list.
- Check lamp socket position for the correct light distribution as specified for any horizontally mounted luminaires.
- When vertically mounted luminaires are used, check for correct tilt angle setting as specified on the Project Plans?
- Are the up-light shields installed?
- Is the lamp wattage checked?
- Were sign lighting luminaires checked for internal fusing, (internal fuses must be removed and located in an adjacent pull box) and correct fuse amperage rating?
- Were external up-light shields installed on sign lighting luminaires?
- Were Certificates of Compliance furnished for the shield?
- Were horizontally mounted luminaires leveled to the horizontal, and are all mounting bolts tightened?
- Were vertically mounted luminaires plumbed to the vertical before the tilt angle was set, and are all mounting bolts tightened?
- Were decals installed in roadway lighting clearly visible from the ground showing the lamp wattage in LED?
- Were all lighting luminaires energized for the 100-hour test?

REFERENCES AND ADDITIONAL INFORMATION

Chapter 07 - Section 701

- Manual on Uniform Traffic Control Devices for Streets and Highways, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C.
- Manual on Uniform Traffic Control Devices for Streets and Highways Part VI, Standards and Guides for Traffic Controls for Street and Highway Construction, Maintenance, Utility, and Incident Management Operations, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C.
- ADOT Traffic Control Design Guidelines, Arizona Department of Transportation, Traffic Group, Phoenix, AZ
- Flagging Handbook, American Traffic Safety Services Association, Fredericksburg, VA Quality Standards for Work Zone Traffic Control Devices, American Traffic Safety Services Association, Fredericksburg, VA
- Quality Guidelines for Temporary Traffic Control Devices and Features Handbook, American Traffic Safety Services Association, Fredericksburg, VA

ASSOCIATED FORMS

Note - *Unless otherwise noted, the below forms are found within "Forms - ADOT Construction Manual" links within Construction and Materials Group (ADOTNet), Engineering and Construction, and the Construction (public web pages).*

- DETECTION LOOP - PRELIMINARY TEST REPORT