

UNIFORM STANDARD SPECIFICATIONS CLARK COUNTY AREA

SPECIFICATION - YEAR 2010 REVISIONS

SECTION(S)	TITLE AND REVISION SUMMARY	EFFECTIVE DATE
623	"Traffic Signals and Street Lighting" – Revisions to update formatting (see detail under "Administrative Revisions") and intelligent transportation systems repair requirements.	7/01/10

ADMINISTRATIVE REVISIONS

SECTION(S)	TITLE AND REVISION SUMMARY	
General	Throughout Uniform Standard Specifications - Added hyperlinks for all references to other Uniform Standard Specification subsections.	7/01/10
General	Throughout Uniform Standard Specifications - Modified all "References to Self" from "Subsection number" to "this section."	7/01/10
104	"Scope of the Work" 104.04.E.3 - Deleted "of these Standard Specifications" at the end of the sentence (reference to self). 104.04D - Changed "Subsection 624" to "Section 624."	1/01/10 7/01/10
105	"Control of the Work" 105.04.A.4 - Changed "Standard Drawings" to "Uniform Standard Drawings." 105.04.A.5 - Changed "Standard Drawings" to "Uniform Standard Drawings" Subparagraph. 105.13.E - Changed first sentence to read: "Construction loads greater than legal loads may be carried over structures within the project which have spans of 10 feet to 20 feet only when the Contractor complies with the above Subparagraph C, numbers 3 through 9 inclusive; however, the limitations as set for in Subparagraph C, numbers 3 through 5 inclusive, may be waived by the Engineer for reinforced concrete box structures which are adequately supported by shoring."	1/01/10
106	"Control of Materials" 106.01.C Added comma after 105.03. 106.03.A- Revised "Section 102.05" to "Subsection 102.05."	7/01/10
107	"Legal Relations and Responsibility to the Public" 107.08.F - Revised use of "Subsection" and "and" to clarify sentence.	7/01/10

SECTION(S)	TITLE AND REVISION SUMMARY	EFFECTIVE DATE
108	<p>“Prosecution and Progress” 108.06.D - Changed “Subsection 101.73” to “Subsection 101.74”</p> <p>108.06.E - Changed “Subsection 101.73” to “Subsection 101.74”</p> <p>108.08.A - Changed “Subsection 101.73” to “Subsection 101.74”</p>	1/01/10
109	<p>“Measurement and Payment” 109.01.Q.4 and 6 - Removed period after F (Fahrenheit) consistent with typical usage.</p>	7/01/10
204	<p>“Rounded and Transition Slopes” 204.05.01.A - Revised "the Subsection" to "Subsection."</p>	7/01/10
208	<p>“Trench Excavation and Backfill” 208.03.11.A - Added comma after subsection number.</p>	7/01/10
212	<p>“Landscaping” 212.02.03.A - Changed the first sentence to read: “It is the intent that all plant materials meet the standards as set forth herein, throughout the life of the contract.”</p>	1/01/10
306	<p>“Lime Stabilized Subgrade” 306.03.04.F.1 - Removed extra space in "ASTM D 1633."</p>	7/01/10
407	<p>“Seal Coat” 407.03.05.A - Revised paragraph to remove reference to section itself.</p>	7/01/10
501	<p>“Portland Cement Concrete” 501.03.04.A.1 - Deleted “o” after the end of the sentence Table 2 – Concrete Mix Designation – Changed Max. Nom. Coarse Aggregate Size for Class C and CA concrete from “50” to “2-1/2” inches.</p> <p>Table 2 – Concrete Mix Designation – Changed Max. Nom. Coarse Aggregate Size for Class C and CA concrete from “50” to “2-1/2” inches.</p> <p>501.02.05.B - Revised paragraph to remove reference to section itself.</p> <p>501.03.06.D.5 - Added period at end of paragraph.</p>	<p>1/01/10</p> <p>7/01/10</p>
505	<p>“Reinforcing Steel” 505.02.01.D - Added no-width optional break character in hyperlink (between "qpl/" and "pdfs") to avoid spreading of letters.</p>	7/01/10
601	<p>“Pipe Culverts – General” 601.03.01.A.1 - Changed this Subparagraph to read: “The pipe shall be bedded as shown in the plans and/or drawings appended to the plans or as specified in the Special Provisions.”</p>	1/01/10

SECTION(S)	TITLE AND REVISION SUMMARY	EFFECTIVE DATE
613	<p>“Concrete Curb, Walk, Gutters, Driveways and Alley Intersections” 613.03.06.A, 613.05.01.A, and 613.05.01.F – Replaced “valley gutter” with “cross gutter”.</p>	1/01/10
623	<p>"Traffic Signals and Street Lighting"</p> <p>623 G.01.01.B - Added closing quote after "Volumes I and II."</p> <p>623 G.01.01.B - Deleted extra space between "completed work" and period.</p> <p>623 G.01.03.D.3 -Added "and" between "monitors, " and "modems."</p> <p>623 G.02.01.D.1 - Deleted extra space in "as directed."</p> <p>623 G.02.01.F.2 - Replaced hyphen with required space in "0.035-inch."</p> <p>623 G.02.02.J - Deleted extra space in "be reviewed."</p> <p>623 G.02.03.B - Added comma after "or equal."</p> <p>623 G.02.04.A.7 - Deleted space at paragraph beginning.</p> <p>623.G.07.M.2 - Deleted paragraph: contains only a period.</p> <p>623.G.01.D.1 - Deleted 2 extra spaces in "as directed by."</p> <p>623.G.01.B - Added end quote after "Volumes I and II."</p> <p>623.G1.01.C - Removed the extra space before the end of the first sentence.</p> <p>623.01.03.D.3 - Added "and" before modems at the end of the paragraph.</p> <p>623 G.02.01.F.2 - Replaced hyphen with non-breaking space in "0.035-inch for" (not an adjective so hyphen not required).</p> <p>623 G.02.01.I.1 - Replaced space after "No." with non-breaking space.</p> <p>623 G.02.03 - Added comma after "or equal" to clarify requirement.</p> <p>623 G.02.04.A.7 - Removed space at beginning of paragraph.</p> <p>623 G.02.07.M.2 - Deleted blank paragraph.</p> <p>623 G.03.02.E - Replaced space with hyphen in "24 hour."</p> <p>623 G.03.02.J - Replaced period with comma after "reel."</p> <p>623.G.03.02.L.2 – Add a comma after “curb and gutter.”</p> <p>623.G.03.04 – Deleted extra paragraph mark before subsection.</p> <p>623 G.03.07.C - Added comma after "firm."</p> <p>623 G.03.07.J - Deleted extra space in "these specifications."</p> <p>623 G.03.07.K - Added opening quote before "Portland Cement."</p> <p>623 G.03.08.A.3 - Uncapitalized E in "Excess."</p> <p>623 G.03.08.S.3 - Deleted extra space in "acceptable material."</p> <p>623 G.03.09.B - Deleted 3 extra paragraph marks. g</p> <p>623 G.03.09.E - Deleted 3 extra paragraph marks.</p> <p>623 G.03.12.A.2 - Deleted extra space at beginning of paragraph.</p> <p>623 G.03.12.A.7 - Deleted extra space at beginning of paragraph.</p> <p>623 T.01.01.A - Deleted extra spaces at end of paragraph.</p>	7/01/10

SECTION(S)	TITLE AND REVISION SUMMARY	EFFECTIVE DATE
623 T.01.01.L.3	- Deleted comma after "AutoCAD format."	
623 T.01.01.L.5.j	- Deleted tab at beginning of paragraph.	
623 T.01.01.L.5.k	- Deleted tab at beginning of paragraph.	
623 T.01.01.L.5.k.3).a)	- Revised "conflict monitor" to have initial capitals consistent with later subsection usage.	
623 T.01.01.L.5.l	- Deleted tab at beginning of paragraph.	
623 T.02.02.A	- Reverted colon to period at paragraph end.	
623 T.02.02.F	- Deleted extra space at beginning of paragraph.	
623 T.02.03.B.1.b	- Deleted comma after "specifications."	
623 T.02.03.B.4.a	- Added comma after "facilities."	
623 T.02.03.B.5.d.2)	- Added comma after "tears."	
623.T.02.04	- Deleted colon at end of title.	
623.T.02.04.A.2	- Deleted extra space in "NEMA TS 1."	
623.T.02.04.H.9	- Added space in ",as."	
623 T.02.05.C.3	- Deleted extra spaces at end of paragraph.	
623 T.02.05.D.1.b.1)	- Added comma after "System Operation."	
623 T.02.05.D.3.c	- Deleted extra space in "be color."	
623 T.02.07.D	- Added comma after "system configuration."	
623 T.02.08.D	- Deleted extra space at beginning of paragraph.	
623 T.02.08.J.1.c	- Numbered paragraph.	
623 T.02.10.B	- Deleted extra space at beginning of paragraph.	
623 T.02.10.B.6.a	- Added "one-" to clarify "one-piece."	
623 T.02.11.B.2	- Removed "in push the button housing."	
623 T.03.02.D.4.b.2)	- Added comma after "System Operation."	
623 T.03.03.A.5.a	- Removed " size" to revise to "The lug shall be sized?"	
623 L.01.01.A	- Deleted extra space at end of paragraph.	
623 L.02.01	- Deleted extra paragraph mark between paragraphs A and B.	
623 L.02.01.C.3	- Added comma after "rain-tight."	
623 L.02.03.C.2.d	- Replaced semicolon with comma after "heavy duty."	
623 L.02.03.L	- Revised "shall be" to "shall have."	
623 L.02.03.Q	- Deleted extra paragraph mark before this paragraph. <i>This revision changed the numbering in the next 3 paragraphs.</i>	
623 L.02.04.B	- Revised "that are accessible through the handholes" to "and shall be accessible through the handholes."	
623 L.02.04.E	- Revised "proper" to "properly."	
623 L.02.06.C.2.a	- Revised ", and controlling the" to "and shall control the."	
623 L.03.01.G.2	- Deleted Note 2 (redundant). <i>This revision changed the numbering in the next two paragraphs.</i>	
623 L.03.02.D.4.a	- Revised "The lug size shall be sized" to "The lug shall be sized."	
623 L.03.03.A	- Deleted extra space at beginning of paragraph.	
623.05.01.A	- Revised "contract documents" to "Contract Documents" consistent with the rest of the sections.	

SECTION(S)	TITLE AND REVISION SUMMARY	EFFECTIVE DATE
624	“Accommodations for Public Traffic” 624.05.01.D - Removed period in "Maintenance of Traffic.", and moved end quote to after the comma.	7/01/10
630	“Sanitary Sewers” 630.03.14.B.3.j - Revised 'Subsection 603.03.14.A - "General," paragraph A.' to read 'Subsection 630.03.14.A, "General." The comma was duplicated and "paragraph A" was redundant.	7/01/10
685	“Video Encoder” 685.03.02 - Revised "Section" to "Subsection."	7/01/10
688	“Remote Data Radio Communication System” 688.05.01.A - Added comma after subsection number.	7/01/10
703	“Bituminous Materials” Table 6 - Revised title to correct "Catonic" to "Cationic."	7/01/10
704	<p>“Base Aggregates” 704.04.04.C.6 - Replaced “standard specifications” with “above noted specifications.”</p> <p>704.04.04.C.7 - Replaced “standard specifications” with “above noted specifications.”</p> <p>704.04.04.D.1.d - Replaced “standard specifications” with “above noted specifications.”</p> <p>704.04.04.D.2 - Replaced “standard specifications” with “above noted specifications.”</p> <p>704.04.04.D.2.a - Replaced “standard specifications” with “above noted specifications.”</p> <p>704.01.02.A – Removed double quotes at beginning of sentence.</p>	<p>1/01/10</p> <p>7/01/10</p>
705	<p>“Aggregates for Bituminous Courses” 705.03.04.B & Table 5 – “ASTM” reinserted where it was accidentally deleted.</p> <p>Table 15 – Corrected misspellings of minimum and maximum.</p>	7/01/10
706	<p>“Aggregates for Portland Cement Products” Table 7 – Revised The Mortar Making Properties of Sand “ASTM C42” to “ASTM C87.”</p> <p>Table 9 – Revised The #100 percentage from “10-12” to “2-12.”</p>	7/01/10
707	“Joint Material” 707.03.03, 707.03.04, 707.03.05 - Deleted “FILLER” at the end of each subsection heading.	1/01/10

SECTION(S)	TITLE AND REVISION SUMMARY	EFFECTIVE DATE
708	<p>“Concrete and Clay Pipe and Drains” Table 2 - Corrected repeated headings that disappeared from the last page where this table split. Corrected borders for some cells in this table where they disappeared.</p> <p>Removed "NO REF" review notations.</p>	7/01/10
709	<p>“Metal and Thermoplastic Pipe” Tables 4 through 7 - Removed "/" where it did not belong in third column. Removed "NO REF" review notations. Corrected 32-hour to include non-breaking hyphen. Corrected "ASSHTO" to "AASHTO."</p>	7/01/10
714	<p>“Paint and Pavement Markings” 714.03.06.B.3.i - Added no-width optional break character in hyperlink between ".com/" and "reports" to avoid spreading of letters.</p>	7/01/10
725	<p>“Elastomeric Bearing Pads” 725.03.01.A (Table) - Removed extra space in "ASTM D 395."</p>	7/01/10
726	<p>“Roadside Materials” 726.03.01.C - Added zero before ".953" in table.</p>	7/01/10

SECTION 622 - BLANK

SECTION 623

TRAFFIC SIGNALS AND STREET LIGHTING

DESCRIPTION

623 G.01.01 GENERAL

- A. Electrical work shall consist of furnishing and installing, modifying or removing traffic signals, school flashers, flashing beacon systems, street and highway lighting systems, Intelligent Transportation Systems (ITS) facilities, sign illumination systems, traffic count stations, electrical equipment in structures, falsework lighting, partial installations for future systems, or combinations thereof, all as shown on the Drawings and as specified in these specifications and the Special Provisions.
- B. The standards for street lighting and traffic signal installation and construction shall be the "Uniform Standard Drawings, Volumes I and II" and these specifications as adopted and approved by the Regional Transportation Commission of Southern Nevada (RTC).
- C. For the purposes of this section, the Maintaining Agency of identified portions of the work described herein shall be the entity specified in the Contract Documents as being responsible for the operation and maintenance of those portions of the completed work. Unless otherwise specified, the Contracting Agency shall be considered the Maintaining Agency for all items of work.
- D. Unless otherwise indicated on the Drawings or specified in the Special Provisions, all materials shall be new.
- E. The locations of traffic signals, flashing beacons, street light and traffic signal poles, roadway lighting fixtures, traffic signs, traffic controller cabinets, electrical services, school flashers, and appurtenances shown on the Drawings are approximate and the exact locations will be established by the Engineer in the field.
- F. All materials furnished and used shall conform to the provisions in Section [106](#), "Control of Materials." The materials shall be manufactured, handled, and used in a manner to ensure completed work with undamaged equipment and materials in accordance with the Drawings, specifications, and Special Provisions.
- G. All systems shall be complete and in satisfactory operating condition at the time of acceptance of the contract.
- H. Where an existing system is to be modified, the existing material shall be reused, salvaged and stockpiled, or abandoned as shown on the Drawings, as specified in the Special Provisions, or as directed by the Engineer.

623 G.01.02 REGULATIONS AND CODE

- A. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), and listed by Underwriters Laboratories, Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable.
- B. In addition to the requirements of the Drawings, these specifications, and the Special Provisions, all materials and workmanship shall conform to the requirements of:
 - 1. *National Electrical Code (NEC).*

2. National Electrical Testing Association (NETA).
 3. *National Electrical Safety Code* (NESC).
 4. Standards of ASTM International.
 5. American National Standards Institute (ANSI) manuals.
 6. International Municipal Signal Association (IMSA) cable specifications.
 7. Institute of Electronic and Electrical Engineers (IEEE).
 8. Illumination Engineering Society (IES).
 9. Rural Electrification Association (REA).
 10. Nevada Occupational Safety and Hazard Act (NOSHA).
 11. National Board of Fire Underwriters (NBFU).
 12. *Manual on Uniform Traffic Control Devices* (MUTCD).
 13. *Uniform Standard Drawings*.
 14. Any local ordinance which may apply.
- C. Wire sizes shall be indicated in American Wire Gauge (AWG).
- D. All work performed on any traffic signal component shall be under the direct on-site supervision of technician or electrician certified by IMSA for Level II Traffic Signals.
1. Actual trenching and foundation excavation activities are not considered construction labor involving traffic signal components until conduits or other electrical components are installed.
 2. At a minimum, a supervisor with the IMSA Level II Traffic Signal certification shall oversee the installation of conduits and other electrical raceways.
 3. Traffic signals are defined as all electrical equipment constructed in public right-of-way that are intended to provide control of traffic and shall include but not be limited to school flasher assemblies, advance warning beacons, traffic signal indications assigning right-of-way, school and other crosswalk signals, advance signal flashers, and intersection flashing beacons.
- E. All work performed on any component of any electrical street lighting or traffic signal system shall be supervised by an electrician that is certified as a Journeyman Electrician. The company shall hold a valid state of Nevada recognized C-2 Electrical Contractor's license.

623 G.01.03 EQUIPMENT LIST AND DRAWINGS

- A. Unless otherwise permitted in writing by the Engineer, the Contractor shall, within 15 days following approval of the contract, submit to the Engineer for approval a list of equipment and materials which the Contractor proposes to install.
1. The list shall be complete as to name of manufacturer, size, and identifying number of each item.
 2. The list shall be supplemented by such other data as may be required, including scale drawings of cabinets showing location and spacing of shelves, terminal blocks, and equipment, including dimensioning.

- B. All submittal information shall be submitted for review, in quadruplicate. A minimum of 10 working days will be allowed for the review and return of the submittal documents.
- C. When the Contractor provides a traffic signal controller cabinet, the circuit diagrams for detector plug connections, the peripheral equipment, and all external solid-state logic shall be provided.
 - 1. The Contractor shall furnish traffic signal cabinet drawings and electrical schematics on CD in AutoCAD format, and 2 copies 24 inches by 36 inches in size.
 - 2. The diagrams shall show the location of the installation and shall list all equipment installed in the cabinet.
- D. The Contractor shall furnish a redlined set of the Drawings and revised Special Provisions to the Engineer prior to inspection showing actual conduit, pull box, and signal/lighting pole locations.
 - 1. The redlined Drawings shall indicate any changes in the detector location, field wiring, signal phasing, and all other technical information for each traffic signal and street lighting installation.
 - 2. The Contractor shall also furnish operation and maintenance manuals with each controller and all other electronic equipment furnished by the Contractor.
 - 3. The manuals shall include any and all peripheral equipment specified herein or in the Special Provisions to be installed with the controller, including but not limited to preempt system, video detection system, loop detection amplifiers, conflict monitors, and modems.
 - 4. As-built Drawings shall be required, and the final submittal requirements shall be as specified in the Contract Documents or directed by the Engineer.
- E. All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation manuals shall be submitted at the time the controllers are delivered for testing, or, if ordered by the Engineer, previous to purchase.
 - 1. This diagram shall show in detail all circuits and parts.
 - 2. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

623 G.01.04 WARRANTIES, GUARANTEES, AND INSTRUCTION SHEETS

- A. Manufacturers' warranties, guarantees, and certifications for materials used in the work and instruction sheets and parts list shall be supplied with materials and shall be delivered to the Engineer prior to acceptance of the project.

623 G.01.05 GLOBAL POSITIONING SYSTEM (GPS) COORDINATES

- A. GPS coordinates shall be determined for all new and relocated traffic signal system, ITS, and street lighting facilities that are connected via the underground conduit system(s) and are visible at ground level, including but not limited to poles, pull boxes, splice vaults, cabinets, and service pedestals.
- B. The GPS coordinates shall be submitted to the Engineer in a format specified in the Contract Documents or by the Maintaining Agency, at the end of the project prior to final acceptance. The Engineer will forward the data to the Maintaining Agency.

MATERIALS

623 G.02.01 CONDUIT

- A. Underground conductors shall be installed in polyvinylchloride (PVC) conduit unless otherwise specified in the Special Provisions or the Drawings.
- B. Conduit shall be listed by the Underwriters Laboratories, Inc., and shall bear the UL label on each length.
- C. Signal conductors and low voltage conductors shall not be installed in high voltage light standards.
- D. The conduit sizes to be used shall be as indicated in the Contract Documents.
 - 1. Conduit sizes shall be 1-1/4 inches minimum nominal diameter for street light conduit, and 2 inches or larger minimum nominal diameter for all other conduit, unless the proposed raceway is attaching to an existing raceway that is smaller or as directed by the Engineer.
 - 2. The size of the existing conduit shall always be matched when connecting conduit to an existing raceway.
 - 3. Conduit reducers shall not be installed.
- E. The Contractor may, at no additional cost to the Contracting Agency and with Engineer approval, use larger size conduit, and where used, it shall be for the entire length of the run from outlet to outlet with no reducing couplings permitted.
- F. PVC coated rigid steel conduit shall consist of galvanized rigid steel conduit conforming to applicable federal specifications and Underwriters Laboratories.
 - 1. The exterior surface of the conduit shall be acid-treated to provide an acceptable surface for plastic coating with a heat polymerizing lacquer with a thickness not to exceed 0.0005-inch thick.
 - 2. A polyvinyl chloride compound shall then be bonded to the prepared conduit with a thickness not less than 0.035 inch for the full length of the conduit except the threads.
 - 3. The bond between the metal and the plastic shall be equal to or greater than the tensile strength of the plastic coating.
 - 4. In addition, the PVC compound shall have the following physical characteristics:
 - a. Hardness: 85+ Shore A Durometer
 - b. Dielectric Strength: 400 (Volts/mil @ 60 cycles)
 - c. Tensile Strength: 3,500 psi
- G. All 90-degree elbows and all other conduit bends of 45 degrees or more installed as part of electrical raceways exceeding 300 feet in length and that are to be used as traffic signal or traffic signal interconnect components shall be PVC coated rigid steel, unless otherwise specified in the Contract Documents or directed by the Engineer. The minimum radius for 90-degree elbows (or equivalent combination of smaller bends) for traffic signal cables shall be 18 inches.
- H. Bell end fittings shall be provided on PVC extensions to rigid steel conduit bends installed in traffic signal cabinets.

- I. End caps with "J" hooks in place to secure the bonding ground wire shall be installed on all spare conduits as directed and to the satisfaction of the Engineer.
 - 1. All traffic signal and street lighting conduits shall have at least one Green No. 8 AWG wire installed, as tracer wire.
 - 2. ITS conduit shall have a 6-pair, REA Specification PE-39, No. 22 AWG Twisted Wire Pair cable installed, in lieu of the Green No. 8 AWG Bond Grounding conductor.

623 G.02.02 PULL BOXES

- A. Pull boxes shall be precast reinforced concrete or composite boxes of the sizes and details shown on the Drawings and Standard Drawings.
 - 1. Reinforcement shall have an H-20 rating.
 - 2. Sides and/or ends of pull boxes shall not be tapered for additional strength.
 - 3. Pull box dimensions shall be constant for the full depth of the pull box.
- B. Steel, cast iron, or non-conductive lids shall be used as specified in the Contract Documents or directed by the Engineer.
 - 1. Concrete pull box covers are not allowed.
 - 2. Pull box covers shall be inscribed "TRAFFIC SIGNAL," "STREET LIGHTING," or "FIBER OPTIC" as appropriate, unless otherwise specified in the Contract Documents or directed by the Engineer.
 - 3. Pull boxes intended for voltages over 600 volts shall be inscribed "HIGH VOLTAGE."
 - 4. Pull box covers inscribed "ELECTRICAL" shall not be permitted.
 - 5. Pull boxes for installation in bridges and bridge parapets shall conform to the dimensions and locations shown on the Drawings.
 - 6. Boxes or vaults formed in concrete shall have metal frames and covers.
- C. The dimensions of all pull boxes and covers shall be manufactured and delivered as shown in the Uniform Standard Drawings within a tolerance of 1/8 inch.
- D. All ITS communication facilities shall be installed in accordance with Sections [680](#), "Fiber Optic Cable," and [681](#), "Fiber Optic Splice and Distribution Equipment."
- E. Enclosures for termination of traffic signal electrical raceways that cross under all roadways shall be a bottomless 24-inch deep P-30 with a nonconductive lid, or a double stacked No. 7 pull box with grounded steel covers with the legend "TRAFFIC SIGNAL," as specified in the Contract Documents or as directed by the Engineer.
- F. All metal parts shall have provisions for attaching a grounding conductor.
- G. All metal pull box lids shall be connected to the bonding ground using bare 7-strand No. 4 AWG copper conductor.
 - 1. The grounding conductor shall be welded to the underside of the metal pull box cover by the Contractor or manufacturer using an exothermal welding process unless otherwise specified in the Contract Documents.
 - 2. The grounding conductor shall have a length of 24 inches above the surrounding grade line.

- H. Existing soils may be used for pull box bedding, unless otherwise specified in the Contract Documents or directed by the Engineer.
- I. Pull boxes installed in undeveloped areas shall have a minimum of an 8-inch concrete collar installed at the top of the pull box, at the final grade, as noted in the Uniform Standard Drawings.
- J. Conduit ends shall be sealed with fittings, caps, or conduit sealant to prevent conduits from being filled with sand and gravel. Conduit ends, fittings, and duct seal to be used shall be reviewed and approved by the Engineer prior to installation.
- K. The Contractor shall not modify pull boxes.

623 G.02.03 EXPANSION FITTINGS

- A. Expansion fittings shall be installed where the conduit crosses an expansion joint in a structure.
- B. Each expansion fitting shall be provided with a bonding jumper of No. 6 AWG copper wire, or equal, if the expansion fittings are attached to metal conduits that are grounded.
- C. Expansion fittings to be used where the conduits exit a structure or bridge abutment shall be reviewed and approved by the Engineer prior to installation.

623 G.02.04 CONDUCTORS AND CABLE

- A. Conductors and cable shall conform to the following specifications:
 - 1. Copper wire shall conform to the applicable portions of ASTM D2220, ASTM B3, and ASTM B8.
 - 2. Insulation for multiple circuit lighting conductors shall be rated at 600 volts, 194 degrees F minimum. Lighting conductors shall be 7-strand No. 4 AWG copper wire with THW-2 or XHHW-2 insulation, unless otherwise shown in the Drawings or indicated herein.
 - 3. Conductors for series lighting shall be No. 6 AWG or No. 8 AWG stranded copper wire insulated with 10/64-inch FAA approved polyethylene compound and rated at 5,000 volts for underground circuits. Conductors for overhead series lighting shall be No. 6 AWG or No. 8 AWG solid, hard-drawn copper.
 - 4. Electrical cable for traffic signals shall be IMSA 20-1 approved signal cable of proper size for the required installation unless otherwise specified in the Contract Documents. All traffic signal cable shall be 25-conductor, No. 12 AWG stranded or No. 14 AWG solid copper wire traffic signal cable as specified in the Contract Documents or directed by the Engineer.
 - 5. All traffic signal field cables and conductors entering the traffic controller cabinet shall be permanently labeled in the cabinet with their purpose or function and which pole is being serviced.
 - a. The wires shall be identified using 1-inch wide UV resistant marking tape and a black marker recommended by the tape manufacturer.
 - b. The tape shall be secured in place using a clear heat-shrink tubing that extends 1 inch past the marking tape along the cable to prevent moisture and dirt penetration.

6. Interconnect cable shall be 6-pair, 22 AWG filled telephone cable in accordance with REA Specification PE-39, current edition, unless otherwise specified in the Contract Documents or directed by the Engineer.
 - a. Splices in the interconnect cable are prohibited.
 - b. The cable shall be terminated only in the traffic signal controller cabinet or separate interconnect pull box unless otherwise approved and directed by the Engineer.
 - c. Intersection street light conductors shall be wired in accordance with the Contract Documents or directed by the Engineer.
7. Insulation for service feeds between the transformer and the service pedestal or pole shall be rated at 600 volts, 194 degrees F minimum.
 - a. Conductors shall be a minimum stranded No. 3/0 AWG copper wire with THW-2 or XHHW-2 insulation, unless otherwise specified in the Contract Documents or directed by the Engineer.
 - b. Copper wire shall conform to the applicable portions of ASTM D2220, ASTM B3, and ASTM B8.
8. Loop lead-in cable shall be IMSA 50-2, 12 AWG stranded tinned copper in accordance with ASTM B33.
 - a. The insulation shall be high molecular weight polyethylene in accordance with ASTM D1248.
 - b. One conductor shall have black insulation and the other shall have clear insulation.
 - c. The shield shall be helically applied with stranded, tinned copper drain wire.
 - d. The overall jacket shall be polyethylene with a 600-volt, 140 degrees F rating.
 - e. The wires shall be twisted a minimum of once every foot of length in accordance with IMSA 50-2.
9. Loop wire other than preformed loops for installation in saw cuts shall meet IMSA 51-5.
 - a. Loop wire shall be single conductor No. 14 AWG, copper wire with 19 strands.
 - b. The insulation shall be 15 mils of black PVC complying with UL 62 with an overall jacket of clear nylon in accordance with ASTM D4066.
 - c. The wire shall be rated for 600 volts and have a nominal OD of 0.25 inch.
 - d. The cable-in-duct system shall meet the performance tests as specified in NEMA standards.

623 G.02.05 SERIES STREET LIGHTING

- A. Overhead wire shall be No. 6 AWG Medium Hard Drawn (MHD) solid bare copper continuous from standard to standard with no splices.
- B. Double wire circuits shall have pressed steel conductor arms at 45 degrees from the pole and 180 degrees from the direction of service.

- C. Where overhead lines change direction, up to 45 degrees, the lines shall be bisected by rotating feeder arms; for angles of change greater than 45 degrees, an additional set of feeder arms shall be provided to maintain proper wire separation.
- D. Underground series wires shall be No. 6 AWG stranded copper with 10/64-inch FAA approved polyethylene compound rated for 5,000 volts.

623 G.02.06 COLOR CODING

- A. For traffic signals and signs, insulation shall be of solid color, or of basic colors with a permanent colored stripe, to identify conductors as detailed below, unless otherwise specified.

CONDUCTORS COLORS AND SEQUENCE I.M.S.A. SPECIFICATIONS 19-2 OR 19-1

Conductor	Base Color	First Tracer
1	Black	
2	White	
3	Red	
4	Green	
5	Orange	
6	Blue	
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White
13	Red	White
14	Green	White
15	Blue	White
16	Black	Red
17	White	Red
18	Orange	Red
19	Blue	Red
20	Red	Green
21	Orange	Green
22	Black	
23	White	
24	Red	
25	Green	

623 G.02.07 ELECTRICAL SERVICE PEDESTALS

- A. Electrical service pedestals to be installed for traffic signals or street lighting systems shall be 120/240-volt, 200-amp, 3-wire, single phase with a 4-jaw meter socket, unless otherwise specified in the Contract Documents.
- B. The main breaker shall be rated for 200 amps, unless otherwise specified in the Contract Documents, or as directed by the Engineer.

- C. The main enclosure of the pedestal shall be a rainproof NEMA Type 3R cabinet with construction complying with UL 50 requirements.
- D. The main body of the pedestal shall be fabricated of 12 gauge metal, corrosion resistant, zinc plated steel with a vandal resistant main door to provide interior access to the breaker compartment and vandal-resistant hood door for access to the meter.
 - 1. A dead-front door shall be provided behind the main door to enclose the internal wiring compartment.
 - 2. Both the main and dead-front doors shall be connected to the main body or frame of the service pedestal by use of stainless steel piano hinges.
 - 3. A twisting lock mechanism shall be provided to secure the dead-front door to the main frame.
 - 4. The hood door protecting the service meter shall be hinged to the main body of the pedestal with a stainless steel piano hinge and include an exterior handle to assist in lifting the hood.
 - 5. The hood door and both hinged doors shall be constructed from 14 gauge, corrosion resistant, galvanized steel.
 - 6. A padlock hasp shall be provided for securing the hood door and the main door.
- E. The overall dimensions of the enclosure shall be 16-1/2 inches wide, 48 inches high, and 17-1/2 inches deep.
- F. A removable utility door shall be provided in the back of the pedestal to allow service to the utility landing lugs. A padlock hasp shall be provided to lock the door in place.
- G. The overall exterior dimensions of the service pedestal shall be 48 inches tall, 16 inches wide, and 18 inches deep.
 - 1. The dimensions of the pedestal shall be within a tolerance of 15 percent.
 - 2. The anchor bolt pattern shall be 14-1/2 inches wide and 12-1/2 inches deep with a 1/2-inch tolerance.
- H. A photocell window shall be provided on the side of the main section of the service pedestal with a clear plastic window material. A protective cover or louvered vents shall be provided for the photocell window to protect the window from vandalism yet allow the PEC to function properly.
- I. All fasteners including rivets, screws, nuts, and bolts shall be stainless steel.
 - 1. Pedestal anchor bolts shall be hot dip galvanized 3/8 inch by 18 inches by 2 inches with corrosion resistant washers and nuts.
 - 2. Anchor bolts shall be interior to the main body of the pedestal.
- J. The main body of the pedestal, the hood, and the main door shall be as specified in the Contract Documents or as directed by the Engineer.
 - 1. The dead-front door shall be polyurethane powder coated inside and out with a gloss white coating.
 - 2. All finishes shall consist of Federal specification 595 polyurethane, industrial grade powder paint with 1.7-mil thickness minimum.
- K. The internal wiring shall be completed with copper conductors rated for 194 degrees F, THW-2 or XHHW-2 insulation, and rated for 600 volts. The wire shall be sized in

accordance with the *National Electrical Code* and Underwriters Laboratories, Inc., except that wire to the street light contactors shall be No. 4 AWG stranded copper with THW-2 or XHHW-2 insulation and wired at the factory.

- L. The pedestals shall be assembled by a manufacturer recognized and endorsed by Underwriters Laboratories, Inc. and shall be marked with the UL stamp of approval on the inside of the main door.
- M. The pedestals shall incorporate a copper main load center, which may be raw copper or tinned.
 - 1. Bus bars for grounding and neutral connections shall be raw copper or aluminum, with facilities for landing a minimum of two No. 1/0 AWG conductors, six No. 2 AWG to No. 12 AWG conductors, and twelve No. 4 AWG to No. 14 AWG conductors.
- N. The pedestal shall be designed to accept GE type THQL or equivalent breakers and shall be equipped as specified in the Contract Documents or directed by the Engineer.
- O. The pedestal shall incorporate a single photocell for controlling both 2-pole, 60-amp lighting circuits.
 - 1. Each lighting circuit shall have a separate test toggle switch (or toggle switch position) rated for 15 amps with sealed leads for testing the circuit during maintenance activities.
 - 2. The test switch shall be affixed to the frame of the pedestal and extend through the dead-front door to be accessible by opening only the main door.
 - 3. The photocell shall be Area Research Lighting model SST-VP-IES, or approved equal.
- P. The utility landing lugs shall be raw copper, aluminum, or zinc coated, as specified in the Contract Documents or directed by the Engineer, and shall be capable of receiving the appropriate sized wire from the transformer as noted on the Drawings.
- Q. When specified, double meter service pedestals shall conform to all requirements of the standard pedestals for each side of the metered section. The overall dimensions of the enclosure shall be 24 inches wide, 48 inches high, and 17 inches deep.
- R. Appropriate labels shall be attached to the inside of the main door including a listing of circuit breakers from various manufacturers that are interchangeable with those supplied in the cabinet. A circuit diagram shall be attached to the front door.
- S. An instruction manual shall be provided with the service pedestal.
 - 1. The manual shall include installation and maintenance instructions and shall contain a wiring diagram of the pedestal and a listing of available circuit breakers to be used in the pedestal.
 - 2. A holding compartment shall be provided on the inside of the door to contain the manual and other plans.
 - 3. A resealable plastic storage bag to hold the manual safe from the environment shall be provided.

CONSTRUCTION

623 G.03.01 MAINTENANCE OF EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

- A. Existing electrical systems including but not limited to traffic signals, ramp metering, highway and street lighting, flashing beacons, school flashers, ITS communications facilities, and sign illumination, or approved temporary replacements thereof, shall be kept

in effective operation for the benefit of the traveling public during the progress of the work, unless prior written authorization is provided by the Engineer to allow for alterations or final removal of the systems.

1. Traffic signal shutdown shall be as directed by Engineer and in the presence of the Maintaining Agency representative.
 2. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless prior authorization is provided by the Engineer.
 3. The Contractor shall request permission from the Engineer and notify the Maintaining Agency in writing 5 normal working days, excluding legal holidays, prior to performing any work on existing electrical systems, including traffic signals and street light systems.
 4. Contractors shall not access traffic signal control cabinets without obtaining permission from the Maintaining Agency.
- B. The Contractor shall submit three 24-hour telephone numbers of responsible Contractor personnel to be contacted in the event there are conflicts while the electrical system is being modified.
- C. The Contractor shall repair or replace any damages caused by Contractor's construction activities to the existing electrical systems and to other public owned facilities in the area, at the direction of the Engineer.
1. These damaged facilities shall be repaired promptly and at the expense of the Contractor in accordance with the Contract Documents, and as directed by the Engineer.
 2. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor or related performance bond.
 3. The cost of repairs may include reimbursement of Contracting and Maintaining Agency personnel wages and materials and/or the cost of other contractors hired by the Contracting Agency to repair the damages caused by the Contractor.
- D. The exact location of existing conduits and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.
- E. Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.
- F. Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the traveling public.
- G. These provisions will not relieve the Contractor in any manner of Contractor's responsibilities as provided in Subsections [107.11](#), "Responsibility for Damage Claims," and [107.16](#), "Contractor's Responsibility for the Work and Materials."
- H. A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction, if authorized in writing by the Engineer.
- I. Where an existing system is being modified, work not shown on the Drawings or specified in the Special Provisions and which is determined by the Engineer as extra work

necessary to keep all or any part of the existing system in effective operation and safe to the public and maintenance personnel shall be measured and paid for in accordance with Subsection [109.03](#), "Extra and Force Account Work."

623 G.03.02 MAINTAINING EXISTING INTELLIGENT TRANSPORTATION SYSTEM (ITS) FACILITIES

- A. ITS communications facilities including, but not limited to, copper wire, fiber optic, microwave, radio systems and the electrical services supplying power to same shall be maintained at all times.
 - 1. Any damage to the ITS system of communication cable is considered to be an emergency and liquidated damages of \$2,500 per day for copper cable and \$7,500 per day for fiber optic breaks shall be assessed to the Contractor by the Contracting Agency beginning 24 hours after the conduit or cable damage.
 - 2. The outer jacket of cable insulation shall remain intact without nicks or scrapes or other damage that may compromise the insulating qualities to avoid replacement of the entire interconnect cable.
- B. A conduit break may be considered the same as a cable break.
 - 1. Conduit breaks shall be repaired by first removing the entire length of interconnect cable before repairing the conduit as directed by the Engineer.
 - 2. The interconnect conduit may then be replaced in the electrical raceway after proven to be undamaged by testing as specified herein for new line installations.
- C. The exact location of existing ITS communications system conduits and pull boxes shall be determined by the Contractor before using any equipment that may damage ITS facilities or interfere with Contracting Agency, Maintaining Agency, or FAST operations. Any damage to any ITS communications cable is considered by the Contracting Agency to constitute an emergency.
- D. Where damage to ITS facilities is caused by the Contractor's operations, the Contractor shall, at no additional cost to the Contracting Agency, begin temporary repairs immediately after the damage occurs and shall proceed with repairs expeditiously until complete.
 - 1. All fiber optic repairs shall be performed in accordance with Sections [680](#), "Fiber Optic Cable," and [681](#), "Fiber Optic Splice and Distribution Equipment."
 - 2. Damaged ITS communications infrastructure shall be repaired by the Contractor within 24 hours of discovery.
 - 3. If the Contracting Agency or the Regional Transportation Commission of Southern Nevada (RTC) determines that the need for repairs are critical, the Contracting Agency or the RTC may begin the work of repairing any damage to the ITS communications facilities within the 24 hours of discovery. The Contracting Agency or the RTC may seek direct reimbursement from the Contractor causing the damage to recover the costs in repairing the damaged ITS communications infrastructure.
- E. Should the Contractor fail to perform the required repairs or replacements to ITS communications infrastructure within the 24-hour period, the Contracting Agency or the RTC may elect to repair the damage using any means possible and the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor, including performance bonds. The Contracting Agency or the RTC may seek

direct reimbursement from the Contractor to recover the costs in repairing the damaged ITS infrastructure.

- F. No splices shall be permitted, unless otherwise permitted in writing by the Engineer in consultation with the FAST Director or designee.
- G. The No. 22 AWG copper interconnect cable shall meet the FAST Specification with a DC resistance of 17.4 ohms/1,000 feet at 68 degrees F. Any cable exhibiting a DC resistance in excess of 18.3 ohms/1,000 feet at 68 degrees F in more than 1 pair of conductors shall be deemed to be damaged when tested and shall be replaced.
- H. Temporary repairs of damage to an extended length of ITS cable or damage at more than a single discrete point may consist of placing cable overhead until permanent replacement is completed.
 - 1. The Contractor shall provide temporary overhead interconnect if necessary while the permanent cable is being relocated or replaced.
 - 2. All temporary aerial installations shall be approved by the Maintaining Agency and FAST and shall be installed as directed by the Engineer.
- I. Permanent restoration of a damaged ITS copper wire interconnect shall be made by removing the damaged cable and replacing with a new cable conforming to REA Specification PE-39, 22 AWG, between the nearest existing terminal boards housed in traffic signal controller cabinets, junction cabinets, or an engineering office at each end of the damaged cable run as determined by the Engineer. The new cable shall be tested after installation for acceptable conductance and continuity to ensure no insulation damage occurred during the installation process.
- J. All damaged ITS cable removed from the system under any of the restoration methods shall be removed from the conduit in continuous lengths, wound on a reel, and returned to the Maintaining Agency.
- K. All cable repairs or restoration to ITS facilities shall be made under inspection by FAST or personnel from the Maintaining Agency in whose jurisdiction the repair is being made.
- L. All materials, equipment, and workmanship incorporated into any cable repair or restoration of ITS facilities shall be guaranteed for a period of 1 year after the final acceptance of the work or equipment.
 - 1. If during the guarantee period any defects or faulty materials are found, the Contractor shall immediately, upon notification by the Engineer, proceed at Contractor's own expense to replace and repair the defective materials and faults.
 - 2. The Contractor shall also be responsible for complete repair to damage of all finishes, fixtures, equipment, and furnishings that may be damaged as a result of this defective equipment and/or workmanship including but not limited to removal and replacement of sidewalks, curb and gutter, and roadway pavement.

623 G.03.03 SCHEDULING OF WORK

- A. Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.
- B. Traffic signals shall not be placed in operation until all discrepancies are corrected, all appropriate roadway pavement markings and signs are in place, and the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

- C. Roadway lighting and traffic signals shall not be placed in operation, including flashing operation, prior to delivery of a full set of redlined drawings to and the successful completion of required tests performed in the presence of the Maintaining Agency's authorized representative. This does not preclude the preparation and submittal of as-built Drawings.
- D. Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor or vendor immediately.
 - 1. Electrical equipment and components shall not be energized until properly grounded as shown in the Contract Documents or directed by the Engineer.
 - 2. All repairs and material replacements shall be completed as directed by the Engineer.
- E. Conductors shall not be pulled into conduit until pull boxes are set to grade, conduit trenches backfilled and compacted, crushed rock sumps installed, and metallic conduits properly grounded.
- F. Under-Deck Lighting and Lighting for Pedestrian Structures:
 - 1. Under-deck lighting for vehicular under-crossings shall be placed in operation as soon as practicable after false work has been removed from the structure.
 - 2. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.
 - 3. If the Engineer orders under-deck lighting or lighting for pedestrian structures placed in operation before permanent electrical service is available, the cost of installing and removing temporary electrical service will be paid for as extra work as provided in Subsection [104.03](#), "Extra Work."
- G. Traffic and pedestrian signals that have been installed and have not yet been energized shall be covered with durable, reusable bright orange traffic and pedestrian head covers, unless otherwise specified in the Contract Documents or directed by the Engineer.
 - 1. Plastic bags shall at no time be used to cover traffic or pedestrian heads.
 - 2. At no time shall traffic and/or pedestrian signals that have been installed and are not in operation remain uncovered.
 - 3. Emergency signals that have not been energized shall also be covered.
 - 4. The color of the signal section shall be visible when energized for testing.
 - 5. Covers shall be mechanically fastened; however, Velcro is not acceptable.
 - 6. The temporary coverings remain the property of the Contractor until the signal is energized and accepted by the Maintaining Agency, at which time the coverings become the property of the Maintaining Agency.
 - 7. The Contractor shall maintain the coverings in proper condition at all times until final acceptance.
 - 8. Coverings that are ripped, torn, shredded, or otherwise allowing any portion of the signal lens to be seen by the public shall be immediately replaced.
 - 9. Coverings that are not replaced immediately shall be replaced by the Contracting Agency and the cost of the covering replacement shall be deducted from any unpaid invoices that have been or will be submitted to the Contracting Agency by the Contractor.

623 G.03.04 HIGH VOLTAGE SAFETY PRECAUTIONS

- A. Before starting work on existing series street lighting circuits, the Contractor shall obtain a daily safety circuit clearance from the Maintaining Agency.
- B. The electrical bypass control shall be switched to the "off" position, fuses shall be removed, and signs posted at the switch box before any work is done.
- C. The Occupational Safety and Health Administration (OSHA) procedure for "lock-out, tag-out" shall be followed in strict compliance for all series street lighting circuits.

623 G.03.05 EXCAVATING AND BACKFILLING

- A. Excavations required for the installation of conduit, foundations, and other facilities shall be performed in a manner to cause the least possible damage to the streets, sidewalks, and other improvements, including private property.
 - 1. Excavations shall not be larger than necessary for the proper installation of conduit, electrical facilities, and foundations.
 - 2. Excavating shall not be performed until immediately before installation of conduit, facilities, and foundations.
- B. Excavations shall not remain open overnight except as approved by the Engineer and only when adequate protection for the public, including pedestrians, is provided.
- C. The material from the excavation shall be placed in a position where the least disruption and obstruction to vehicular and pedestrian traffic will be realized and the least interference with surface drainage will occur.
- D. Surplus excavated material shall be removed and disposed of by the Contractor outside of the right-of-way.
- E. At the end of each day's work, and at other times when construction operations are suspended, equipment and other obstructions shall be removed from the right-of-way.
- F. Structural excavation and backfill shall conform to the requirements of Sections [206](#), "Structure Excavation," and [207](#), "Structure Backfill."
- G. Trench excavations shall be backfilled in conformance with the requirements of Section [208](#), "Trench Excavation and Backfill."
- H. Backfilled excavations shall be kept well filled and maintained in a smooth and well-drained condition, until permanent resurfacing is completed as specified in Subsection [208.03.21](#), "Cutting and Restoring Street Surfacing."
- I. Unless otherwise specified in the Contract Documents, excavation in the street and highway shall be performed in such a manner that not more than 1 lane of traffic is restricted in either direction at any time, or as approved by the Engineer.
- J. All streets upon or within which any work is being done shall be kept open to all traffic by the Contractor, as specified in Subsection [104.04](#), "Maintenance of Traffic," unless otherwise provided in the Special Provisions, or as approved by the Engineer.
- K. Surface and underground materials, irrigation systems, utilities, and other constructions shall be restored in kind to or exceeding the original conditions by the Contractor as part of the excavation and backfilling operations.
- L. Barricading shall conform to the latest editions of the Traffic Control Plans for Highway Work Zones for the Clark County Area and the *Manual on Uniform Traffic Control Devices*.

623 G.03.06 REMOVING AND REPLACING IMPROVEMENTS

- A. Improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material, and other improvements removed, broken, or damaged by the Contractor, shall be replaced or reconstructed in compliance with the applicable sections of these specifications.
- B. Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, it shall be repaired in accordance with Subsection [202.03.02](#), "Removal."
- C. The outline of all areas to be removed in Portland cement concrete sidewalks and in pavements shall be cut to a minimum depth of 1-1/2 inches with an abrasive type saw prior to removing the sidewalk and pavement material.
 - 1. Cut for the remainder of the required depth may be made by any method satisfactory to the Engineer.
 - 2. Cuts shall be neat and true with no shatter outside the removal area.

623 G.03.07 FOUNDATIONS

- A. Foundations for traffic signal and lighting poles, traffic signal cabinets, and service pedestals shall be concrete conforming to Section [501](#), "Portland Cement Concrete."
- B. For posts, poles, and pedestals, a 4-inch minimum foundation cap or crash cap consisting of grout or concrete as specified in the Contract Documents or directed by the Engineer shall be poured after the post, pole, or pedestal is in proper position.
 - 1. Grout shall not contain coarse aggregate and shall conform to Subsection [501.03.12](#), "Mortar."
 - 2. Grouting material to be used for the crash cap may be mixed by the Contractor on-site as directed by the Engineer.
- C. The bottom of concrete foundations shall rest on firm, undisturbed ground.
 - 1. In addition, for traffic signal foundation installations, the bottom 2/3 of the concrete foundation shall be poured against undisturbed soil.
 - 2. If the signal foundation is to be placed in an area which has been filled, the fill shall be compacted to 95 percent of the original compaction as specified elsewhere in these specifications and the bottom 2/3 of the foundation shall be poured in drilled 95 percent compacted fill.
 - 3. Forms shall be true to line and grade.
 - 4. Tops of footings for posts and poles, except special foundations, shall be finished 1 inch above grade of curb or sidewalk or as directed by the Engineer.
 - 5. The exposed portions of the foundations shall be formed to present a neat appearance.
- D. Forms shall be rigid and securely braced in place.
 - 1. Conduit ends and anchor bolts shall be held in place by means of a template until the concrete sets.
 - 2. Both forms and soil which will be in contact with the concrete shall be thoroughly moistened before placing concrete.
 - 3. Forms shall not be removed until the concrete has thoroughly set.

- E. Standard surface finish shall be applied to exposed surfaces of concrete. All top surface areas of traffic signal cabinet bases and service pedestals shall be smoothed finished with a trowel.
- F. Where the edge of a concrete foundation extends within 18 inches of any existing concrete improvement, a slab with a minimum thickness of 4 inches shall be extended to meet the existing improvement.
- G. Traffic signal cabinets shall have a 4-inch thick concrete slab installed in front of the cabinet.
 - 1. The concrete slab shall be as wide as the signal cabinet foundation and a minimum of 4 feet in length from the cabinet base.
 - 2. The cost of this concrete slab shall be incidental to the cost of the foundation.
- H. Electrical service pedestals installed in remote locations where sidewalk does not exist shall also have a concrete slab.
 - 1. The concrete pad shall be a minimum of 2 feet on each side of the pedestal foundation and 4 feet in front of the electrical service pedestal.
 - 2. The concrete slab shall be 4 inches thick.
 - 3. The cost of the concrete pad shall be incidental to the cost of the pedestal foundation.
- I. Concrete for Type XX poles, XX-A poles, and XX-B poles shall set for a minimum of 10 days unless otherwise approved by the Engineer. Concrete for smaller bases shall set for a minimum time of 72 hours.
- J. Concrete foundations shall be installed in accordance with all pertinent sections of these specifications and the Uniform Standard Drawings. Minimum concrete curing times before live loads can be set on the foundation shall be as specified therein and as directed by the Engineer.
- K. Traffic signal and luminaire arms shall be considered live load and may be mounted on the poles only after the concrete foundations have set for the minimum curing times as prescribed in Sections [501](#), "Portland Cement Concrete," and [502](#), "Concrete Structures."

623 G.03.08 WIRING AND CONDUIT

- A. Wiring shall conform to appropriate articles of the latest version of the *National Electrical Code* (NEC).
 - 1. Wiring within cabinets, junction boxes, and so forth shall be neatly arranged.
 - 2. Powdered soapstone, talc, or other approved lubricant shall be used when installing conductors in conduit.
 - 3. Any excess lubricant shall be removed as directed by the Engineer.
 - 4. All conduits shall be PVC unless otherwise specified in the Contract Documents.
- B. Each conductor shall have a minimum of 18 inches of slack coiled within each standard and at least 2 feet of slack coiled in each pull box. The length of slack shall be that amount of extra conductor that is available to be pulled completely out of the pole shaft or pull box.
- C. Series lighting cable shall be installed without splices from luminaire to luminaire and from service to luminaire unless otherwise specified.
 - 1. Multiple lighting conductors may be spliced in the base of standards or in pull boxes adjacent thereto.

2. Signal cable shall run from terminal to terminal without splices unless otherwise indicated on the Drawings.
- D. Splices for street light cables shall be split bolt or "gel-cap" type unless otherwise specified in the Contract Documents or directed by the Engineer.
 1. The gel-cap type shall consist of a kit containing a high abrasive and impact resistant clear elastomer cap factory-filled with cross-linked silicon gel for environmental sealing.
 2. The silicon gel shall not become hard or brittle and shall have a temperature tolerance of -40 degrees F to +221 degrees F.
 3. The cap, clamp, and gel used for the gel-type splice kit shall be UV-resistant.
 4. Kits shall contain a split bolt connector and shall accommodate range of cable sizes specified in the Contract Documents or directed by the Engineer.
 5. Gel-cap-type connection shall also permit removal and re-entry of wiring for maintenance purposes without damage to the splice kit.
- E. Conductor connector types to be used shall be approved by the Engineer prior to installation.
- F. When conductors and cables are pulled into the conduit, all ends of the conductors and cables shall be taped to exclude moisture. Ends of spare conductors shall be taped.
- G. All new traffic signal and street lighting conduit for future use shall have a 8 AWG stranded copper conductor with green THW-2 or XHHW-2 insulation which is secured at both ends by a conduit cap with a J-hook.
 1. A yellow polyethylene pull string shall also be installed in the conduits for future use.
 2. The 8 AWG green conductor shall remain in the conduit at all times for locating and grounding purposes.
 3. All splices shall be performed using waterproof methods.
- H. The outer jacket of insulation for all multi-conductor traffic signal cable shall be removed from the cable that is interior to the signal poles beginning at the base handhole, unless otherwise directed by the Engineer.
 1. The Contractor shall ensure that the proper length of each color of wire is available to route to the appropriate terminal.
 2. Splices and/or wire jumpers between adapter terminals shall not be permitted.
 3. Wiring shall be installed as specified in the Contract Documents or directed by the Engineer.
- I. The Contractor shall always install wire between the pole-mounted "J" box and all spare traffic signal tenons on traffic signal mast arms.
 1. These conductors shall be 14 AWG UF wire, and shall be uniquely identified in the J-box.
 2. A minimum of 6 conductors shall be installed for the 2 end spare tenons and 4 conductors for tenons elsewhere on traffic signal mast arms.
 3. All unused tenons shall be sealed with 10 mil tape.
- J. Conductors shall run from terminal to terminal without splices unless otherwise indicated in the Contract Documents or directed by the Engineer.

1. The ends of all conduits shall be well reamed to remove burrs and rough edges.
 2. Field conduit cuts shall be made square and true so that the ends will butt or come together for the full circumference in the couplings or adapters.
 3. Slip joints or running threads shall not be permitted for coupling metal conduit.
- K. Couplings for steel conduit shall be tightened until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run.
- L. Conduit ends shall be threaded and capped with standard pipe caps until wiring is installed. Approved conduit bushings shall be installed when the caps are removed.
- M. Manual or power-operated equipment normally used for cutting rigid steel conduit is acceptable for use in cutting PVC coated rigid steel conduit.
1. PVC shall not be peeled back before cutting and all cuts shall be reamed.
 2. Threading shall be the same as for non-coated rigid conduit.
 3. All scarred and grip marked areas shall be touched up with approved heavy consistency coating compound approved by the Engineer.
- N. All couplings and threaded fittings for PVC coated rigid steel shall be hand tightened prior to using a wrench.
1. All wrench marks and scores shall be recoated and joints shall be sealed with heavy consistency PVC compound.
 2. The Contractor shall ensure that the final installation does not have exposed metal areas.
- O. Standard field bending techniques shall be used which typically use a shoe 1 size larger to accommodate the larger pipe diameter.
1. Rigid steel conduits shall be bent without crimping or flattening.
 2. No single run shall include more than two 45-degree bends and two 90-degree bends without prior approval by the Engineer.
- P. PVC coated rigid steel conduit, 2 inches in diameter or larger, shall be used for all bends, except for 90-degree bends at street light pole and service pedestal foundations where separation to the intended pull box, cabinet, service pedestal, or traffic signal pole is more than 50 feet. The radius of all 90-degree elbows for traffic signal and ITS conduits shall be a minimum of 24 inches.
- Q. Conduit terminating in pedestals, cabinets, traffic signal poles, and lighting poles shall be a minimum of 2 inches in diameter, unless otherwise specified on the Drawings, and shall extend 2 to 3 inches above the foundation or crash cap, whichever is higher.
1. The conduits shall be straight.
 2. Conduits shall not extend above the lower handhole rim or grounding connection, whichever is lowest.
- R. Traffic signal and roadway lighting conduit shall enter concrete pull boxes from the bottom and shall terminate at least 2 inches inside the box wall and 4 to 6 inches above the bottom of the pull box.
1. There shall be at least 6 inches of clearance between the top of the conduits and the bottom of the pull box cover.

2. The conduits shall be installed to facilitate pulling of conductors.
 3. Conduit entering the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear.
 4. At all outlets, conduit shall enter from the direction of the run.
 5. ITS communications installations may allow entry in the side of the pull box or communications vault.
- S. Conduits shall be lowered as necessary in the vicinity of poles, posts, pull boxes, electrical vaults, and other electrical enclosures for the conduits to facilitate entrance into the enclosure.
1. The Contractor shall not modify traffic signal/roadway lighting pull boxes, electrical vaults, signal or lighting poles or posts, cabinets, pedestals, or any other electrical device for the purpose of entering the device with the conduits without written approval of the Engineer.
 2. ITS communications installations may be field modified only with the approval of and as directed by the Engineer.
 3. All entry points shall be sealed and form fitted with grout or other acceptable material approved by the Engineer.
- T. Existing underground conduit to be incorporated into a new system shall be cleaned by blowing out with compressed air, or by other methods required by the Engineer.
- U. Conduit runs shown on the Drawings are for bidding purposes only and may be changed with the approval of the Engineer to avoid underground obstructions.

623 G.03.09 ELECTRICAL SERVICE

- A. Electrical service points, when required for street lighting, traffic signals, and other electrical constructions in the road right-of-way, shall be as indicated on the Drawings.
- B. Electrical service points for electrical systems, including but not limited to traffic signals, street lighting, school flashers, pedestrian crossing flashers, emergency signals, sign lighting, and high mast lighting, shall be coordinated with the power company by the Contractor and constructed where indicated on the Drawings.
1. Alternate service locations approved by the power company may be adopted as directed by the Engineer.
 2. Traffic signal electrical services shall be as shown on the Drawings unless otherwise approved and directed by the Engineer.
 3. Street lighting electrical services shall be as close to the center of the circuit or system as possible.
- C. Pad-mount services, when called for, shall conform to the Uniform Standard Drawings as applicable.
- D. The Contractor shall furnish and install conduit and conductors to the service point as shown on the Drawings or as required to complete the installation, but under no circumstances shall the conduit and conductor sizes be less than the minimum sizes shown in the Uniform Standard Drawings. A No. 5 pull box shall be installed directly in front of the service pedestal with conduit stubbed from the load side of the pedestal.

- E. Electrical conductors for service shall have THW-2 or XHHW-2 insulation and shall be 3/0 AWG, stranded, copper wire unless otherwise specified in the Contract Documents or directed by the Engineer.
- F. Electrical service shall be inspected, approved, and "tagged" by a representative of the Agency authorized to order electrical service.
 - 1. The Contractor shall complete all utility connections, wiring, crash cap, grounding, and bonding within the service pedestal prior to calling for inspection.
 - 2. The Contractor shall conform to the inspection process of the Agency authorized to order electrical service.

623 G.03.10 PULL BOXES

- A. A minimum of 6 inches of clearance shall be maintained between the top of the conduits and the bottom of the pull box cover.
- B. A minimum of 4 inches of conduit shall extend into the pull box.
- C. Conduit caps shall be installed to help prevent the entry of foreign material into the electrical raceway.
- D. Traffic signal and roadway lighting pull boxes shall not be modified by the Contractor.
 - 1. Entry holes into pull boxes and electrical vaults shall be cut or "knock-outs" provided by the manufacturer as designated in the Drawings.
 - 2. ITS communications pull boxes and vaults may be field modified only with the approval of and as directed by the Engineer.
 - 3. All entry points shall be sealed and form fitted with grout or other acceptable material approved by the Engineer.

623 G.03.11 SIGNS ON TRAFFIC SIGNALS

- A. All 24-inch by 30-inch or larger traffic signs mounted on traffic signal mast arms shall include a wind brace, unless otherwise specified in the Contract Documents or directed by the Engineer.
- B. The wind brace shall be equal to a minimum of 1-inch wide by 3/16-inch thick aluminum sheeting material connected to the top and bottom of the sign and wrapped around the mast arm.
- C. There shall be a wind brace installed every 12 inches on the sign panel.

623 G.03.12 ITS COMMUNICATIONS INFRASTRUCTURE

- A. Communications infrastructure installed for the use of the FAST shall meet the following specifications:
 - 1. The communications conduit shall run straight through the pull box, entering the side of the box near the bottom, to allow for a continuous fiber optic pull of no more than 6,000 feet.
 - 2. The cover depth from the finish grade of all conduits shall be a minimum of 30 inches with allowances for conduit to rise near pull boxes for entry points. If conduit exists adjacent to the proposed conduit installation, the depth and location of the end of the new conduit shall be required to match the existing conduit.

3. The installation of a Type 200 Splice Vault as shown in the Uniform Standard Drawings with the letters "FIBER OPTIC" inscribed on the lid shall be as shown on the Drawings. At these splice point locations, a "sweep" with radius of 24 inches minimum shall be installed with the angle of entry/exit conducive to pulling fiber optic cable directly out the lid of the vault without the use of pulleys inside the vault.
4. Innerduct shall not be used unless specifically required in the Contract Documents. If innerduct is proposed, the specific use of each innerduct cavity shall be as identified in the Contract Documents or approved by the Engineer.
5. All buried conduits shall have underground marking tape placed 12 inches above the installed conduit and marked with the letters "FIBER OPTIC." GPS coordinates shall be determined for all new and relocated traffic signal system and street lighting facilities that are connected via the underground conduit system and are visible at ground level as specified in Subsection [623 G.01.05](#), "Global Positioning System (GPS) Coordinates."
6. For roadway projects where the sidewalk, curb, and gutter are already installed and communications facilities are required, the appropriate size conduit may be installed at the lip of gutter as shown on the drawings or as approved by the Engineer.
7. Installation of fiber optic cable shall conform to Section [680](#), "Fiber Optic Cable."
8. Conduit caps with J-hooks to support the interconnect cable shall be installed for all spare conduit openings to prevent the entrance of debris into the electrical raceway.
9. A 6-pair, 22 AWG interconnect cable, complying with REA Specification PE-39, current edition, interconnect cable shall be installed in all ITS conduit runs.

TRAFFIC SIGNAL SECTION

DESCRIPTION

623 T.01.01 GENERAL

- A. Traffic signal construction shall consist of furnishing, installing, modifying, or removing traffic signals, school flashers, flashing beacons, changeable message signs, traffic count stations, conduits for future traffic signals, and other electrical installations in the roadway right-of-way as shown and specified in the Contract Documents.
- B. The locations of traffic signal poles, controller cabinets, electrical services, and other associated equipment shown on the Drawings are approximate. The Engineer will confirm exact locations of these items in the field.
- C. All materials furnished and used shall be manufactured, handled, and used in a manner to ensure completed work with undamaged equipment and materials in accordance with the Drawings, specifications, and Special Provisions. Engineer approval of all materials shall be required prior to installation.
- D. All systems shall be complete and in satisfactory operating condition at the time of acceptance including successful completion of all testing required by these specifications.
- E. All work performed on any traffic signal component shall be under the direct on-site supervision of an electrician or technician certified by IMSA for Level II Traffic Signals.
 1. Actual trenching and foundation excavation activities are not considered construction labor involving traffic signal components until conduits or other electrical components are installed.

2. An electrician with IMSA Level II Traffic Signal certification shall supervise the installation of electrical raceways.
 3. Traffic signals are defined as all electrical equipment constructed in public right-of-way or easements that are intended to provide control of traffic and shall include but not be limited to school flasher assemblies, advance warning beacons, traffic signal indications assigning right-of-way, school and other crosswalk signals, advance signal flashers, and intersection flashing beacons.
- F. The Contractor is responsible for locating and protecting all underground and aerial utilities and constructions.
1. The exclusion of utilities and other structures on the Drawings or in the Special Provisions does not limit the Contractor's responsibility for these construction elements.

MATERIAL

623 T.02.01 TRAFFIC SIGNAL CONTROLLER CABINETS

- A. The type of traffic signal controller cabinet to be furnished shall be a Type VIII cabinet, and shall conform to Drawing No. 404.307, sheet 1 of 1, in Volume II of the Uniform Standard Drawings.
1. This is commonly referred to as an "R" cabinet.
 2. The cabinet shall be fabricated of sheet aluminum.
 3. All external seams exposed to the outside shall be 100 percent welded (no gaps).
- B. All cabinets shall be provided as a complete unit to include all shelves, foundations, anchor bolts with template, a standard number 2 traffic signal cabinet lock, interior cabinet lights, termination strips, cable harnesses, convenience outlets, circuit breakers, load switches, transfer relays, jumpers, completely wired back panel, video and loop detection interface panel and harnesses, loop detector amplifiers, and emergency vehicle detection equipment and interfaces, as a minimum.
- C. Each cabinet shall be weatherproof, properly ventilated, and have at least two 110 CFM ventilation fans, with each fan having an independent thermostat.
- D. The Contract Documents shall specify whether the cabinet finish is painted or polished aluminum.
1. If a painted finish is required, the cabinet finish shall consist of Federal Specification 595 polyurethane, industrial grade pure white powder paint with 1.7 mil thickness minimum or approved equal.
 2. The cabinet shall be finished both inside and out.
- E. Lifting tabs shall be provided on the center and top of both side panels to assist in the placement of the cabinet by overhead supports. The lifting tabs shall not be fillet welded permanently in place.
- F. Cabinets shall be designed to use fully adjustable shelf-mounting rails of uni-strut design.
1. The rails shall be mounted on the interior of each side panel of the cabinet and shall use spring nuts in the rail channels to tighten the bolts that support the shelves.
 2. Cabinets that use carriage bolt assemblies are not acceptable.

3. There shall be 3 shelves provided with all cabinets.
 4. Each shelf shall be 12 inches deep and the full width of the cabinet.
 5. The middle shelf of the cabinet shall have a 30-inch wide, pullout shelf mounted below for use as a laptop computer table.
 6. The pullout shelf shall be manufactured of the same material and shall be the same depth as the supporting shelf.
 7. The pullout computer shelf shall have a compartment for storing cabinet prints that is accessed by lifting the shelf top.
 8. The compartment shall be the full depth of the pullout computer shelf and shall be a minimum of 1-1/2 inches and a maximum of 2 inches in height.
- G. An emergency access shall be provided in the front of the door to allow police personnel to place the signal indications in the red flashing mode of operation. The police panel door shall be hinged to the main door using a stainless steel piano hinge and shall be keyed with a standard police key lock.
- H. All cabinets shall have the door mounted with a stainless steel piano hinge welded or bolted to door and jamb.
1. There shall be a standard multi-point door stop to lock the door open at 45, 90, and 180 degrees and a supplemental, single-arm door stop to add stability to the door when locked open.
 2. The 3-position doorstop shall be mounted at the bottom of the cabinet door and the single-arm door support shall be mounted at the top of the cabinet.
 3. Each doorstop shall be fully retractable so as not to interfere with the door's closing and opening operation.
 4. When specified, a rear access door shall be provided.
- I. Anchor bolt holes in each cabinet shall conform to the anchor bolt pattern specified in Standard Drawing 404.213.
1. All cabinets shall be supplied with completely galvanized anchor bolts and foundation/bolt template in accordance therewith.
 2. Modification of the controller cabinet to fit alternate anchor bolt patterns shall not be allowed without prior approval by the Engineer.
- J. Cabinets shall have 2 fluorescent light fixtures with lamps mounted in the cabinet interior.
1. One light shall be mounted over the door, at a location least likely to be damaged, and shall be a minimum of 20 inches in length.
 2. The second fluorescent fixture shall be 15 watt and shall be attached to the bottom of the lowest shelf above the back-panel and field terminals.
 3. Both fixtures shall be switched automatically by the door to illuminate the lights when the door is opened, and de-energize them when the door is closed.
- K. The back panel in each cabinet shall be wired to the NEMA TS 2 Type 2 standard inputs and outputs.
1. Standard NEMA A, B, and C connectors shall be provided for connection to the controller.

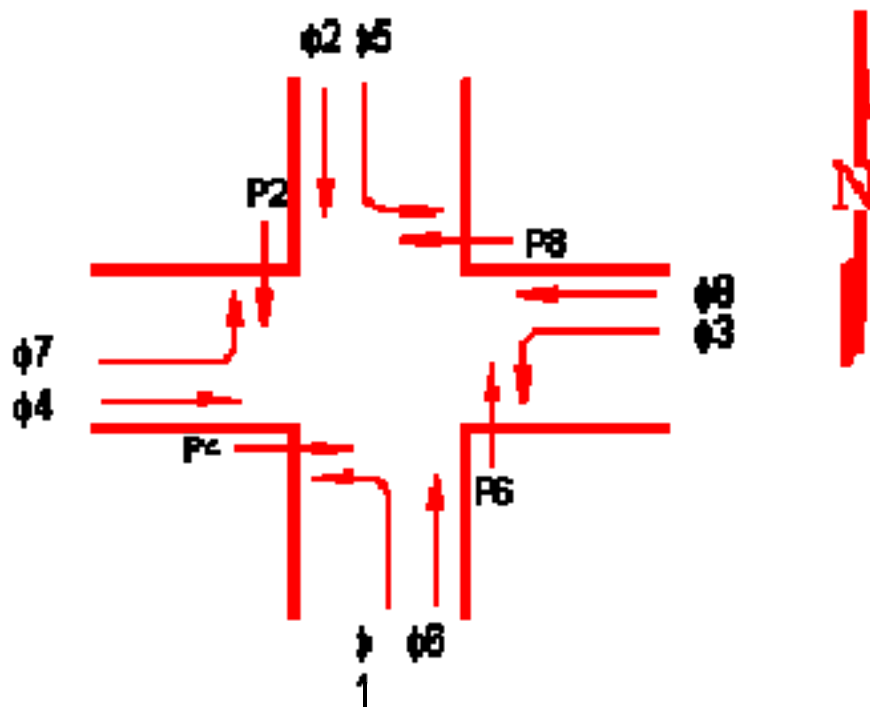
2. The wiring harness for each connector shall provide a termination point onto the back panel for all pins of each connector, including spares or unassigned pins.
 3. The terminals shall be clearly marked as to their associated function, with silk-screened letters and numbers on both sides of the back panel or other pre-approved method of marking.
- L. All traffic signal controller cabinets shall comply with the following conditions:
1. All cabinet harnesses and wiring shall be neatly and firmly laced or bound together (with tie-rape or other pre-approved equivalent).
 2. Every terminal shall be numbered and identified in accordance with the cabinet wiring diagrams and prints.
 3. Cabinet wiring diagrams shall be supplied with the cabinet that show and identify the connectors for all equipment, and for all switches, terminal blocks, relays, flashers and signal control bases. Supply 2 complete sets of wiring diagrams on 36-inch by 24-inch size paper. A compact disc (CD) with the wiring diagram and cabinet schematic drawn in AutoCAD format shall also be supplied.
 4. The cabinet wiring diagram shall have an intersection sketch with signal heads and push-buttons identified as related to phasing.
 5. The following equipment shall be furnished and wired in all cabinets:
 - a. Three single-pole, surface-mount circuit breakers shall be installed in the controller cabinet to protect the different circuits indicated below.
 - 1) The circuit breakers shall accommodate a No. 1/0 AWG, 7-strand, copper, 600-volt service conductor.
 - 2) A supplemental terminal block may be installed if needed to accommodate the smaller terminal lug sizes.
 - a) One 20-amp circuit breaker to operate all the electronic equipment including the controller, conflict monitor, detection equipment, and preemption equipment and the upper utility plug.
 - b) One 15-amp circuit breaker for the fan, light, and lower utility plug.
 - c) One 40-amp circuit breaker to provide power to illuminate all the field indications at the intersection external from the cabinet.
 - b. There shall be a specific unfused, raw copper terminal, able to accept 1/0 AWG, 7-strand, copper 600-volt power conductor, for the neutral conductor of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent, on the side panel of the cabinet.
 - c. There shall be a specific unfused, raw copper terminal, able to accept 1/0 AWG, 7-strand, copper 600-volt power conductor, for the chassis ground wire. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent, on the side panel of the cabinet.
 - d. The terminal blocks for connecting the pedestrian and vehicle field wires which illuminate the independent signal heads shall be Thomas and Betts No. 35301, or approved equivalent. The mounting height to the bottom of these terminal blocks shall be between 14 and 18 inches from the bottom of the cabinet base.

- e. Terminal blocks Cinch 12-142 with Thomas and Betts chair lugs, or approved equivalent, shall be used for connection of pedestrian push button field conductors.
- f. Terminal blocks shall be provided for all pins on wiring harnesses and for all connectors of the cabinet equipment.
 - 1) Separate terminal blocks for termination of the wiring harnesses for the controller, conflict monitor, loop and video detection systems, and emergency vehicle preemption system shall be provided.
 - 2) All connector pins shall be wired to the harnesses and terminated on the appropriate block.
- g. A minimum of two 16-terminal, compression type, copper ground strips shall be mounted to each side of the interior cabinet wall for connection of all neutral conductors.
 - 1) These terminal strips shall not be grounded and will be connected to the terminal block that accepts the #2 stranded wire for the neutral power supply wire.
 - 2) The terminal strips shall be mounted from 2 inches to 4 inches up from the bottom of the cabinet.
- h. A 24-position, compression-type, copper grounding strip shall be mounted on and grounded to each side of the cabinet wall for connection of all grounding conductors.
 - 1) These terminal blocks shall be connected to ground and shall be connected to the terminal block that accepts the No. 2 AWG stranded wire for the grounding conductor of the power supply.
 - 2) The grounding strips shall be mounted 4 inches above the bottom of the cabinet.
- i. Two dual-circuit, solid state, NEMA jack-mounted flashers having a flash rate of 50 to 60 flashes per minute (see NEMA TS 1, Section 8, "Solid State Flashers") shall be installed.
 - 1) The red position of the load switch bays shall be operated from the flasher contacts as follows:
 - a) Flasher 1, contact A - phases 1, 4, and OLA
 - b) Flasher 1, contact B - phases 5, 8, and OLB
 - c) Flasher 2, contact A – phases 2, 3 and OLC
 - d) Flasher 2, contact B – phases 6, 7 and OLD
 - 2) The red transfer relays will be wired in such a manner that the field wire outputs shall be flashing when the relays are de-energized. These transfer relays shall be energized to operate the traffic signal with colors.
- j. A single, duplex, U-ground type of convenience outlet shall be furnished for tools and lighting.
 - 1) It shall have an integral ground fault protection device and be installed adjacent to the breakers in the lower portion of the cabinet on the right side panel.

- 2) The power source for this outlet shall be the 15-amp circuit breaker.
 - 3) Two single, duplex, U-ground type of convenience outlets shall be furnished for video equipment and other electronic test equipment.
 - a) Neither shall have an integral ground fault protection device.
 - b) The outlets will be located no more than 12 inches from the roof of the cabinet, on the right side panel of the cabinet interior.
 - c) The power source for these outlets shall be the 20-amp circuit breaker.
 - 4) A fourth, single, duplex, U-ground type of convenience outlet shall be furnished for other electronic test equipment.
 - a) It shall not have an integral ground fault protection device.
 - b) This will be located no more than 12 inches from the roof of the cabinet, on the left side panel of the cabinet interior.
 - c) The power source for this outlet shall be the 20-amp circuit breaker.
- k. Police Panel Switch:
- 1) There shall be a double-pole, double-throw switch behind the police auxiliary door.
 - 2) This shall be identified "Auto/Flash."
 - 3) The Flash position of the switch shall cause the following:
 - a) De-energize signal light power and place the intersection to red flashing operation through the Conflict Monitor (see d) below). The controller power, however, shall remain energized.
 - b) Activate the Stop Time function within the controller. This will be accomplished through the Conflict Monitor (see d) below).
 - c) Provide logic ground to inform the 2070N controller that the Police Flash Switch has been turned on to put the traffic signal on flash, on Pin AA, Controller Plug A.
 - d) De-energize +24v II to the Conflict Monitor to cause it to fail, which in turn causes the Conflict Monitor to provide a logic ground to Controller Plug A, Pin n, and Stop Time to controller. This circuit shall be diode-isolated.
 - 4) When the police switch is placed back into Auto position, the intersection shall be transferred from red flashing operation to normal operation.
- l. The following switches shall be installed at the center of the interior of the cabinet door and shall function as described.
- 1) The Controller Power switch shall be labeled "On-Off" and wired to de-energize only the controller power when switched to the Off position.
 - 2) Tech Flash switch shall be labeled "Auto-Flash."
 - a) It shall be wired to remove the electrical power feeding the load switches and transfer relays when the switch is placed in the Flash position.

- b) Placing the switch in Flash shall cause the intersection signals to flash red for all movements except the pedestrian movements which shall show no indication.
 - c) The controller, conflict monitor, and all other cabinet equipment shall remain energized.
 - d) A logic ground shall be applied to Controller Plug A, Pin AA to inform the controller that the Tech Flash switch has been put on flash.
 - e) The Controller shall not stop timing while the Tech Flash switch is in the Flash position.
 - f) The intersection shall return to normal operation when the Tech Flash switch is placed back into the Auto position.
- 3) Stop Timing switch (identified "On-Off") shall be wired to Stop Time ring 1 and ring 2 on the controller when switched to the On position.
- 4) The Interval Advance switch shall be a momentary, pushbutton switch.
- a) The switch shall make electrical connection to the back panel through a 1/4-inch phone jack labeled "Interval Advance."
 - b) The Interval Advance switch shall be enabled by the Manual Control Enable (MCE) switch and wired to manually step the controller through intervals.
 - c) The Interval Advance switch shall have a guard to keep from accidentally advancing the controller.
- 5) The Manual Control Enable switch shall be labeled "MCE" and shall be wired to enable MCE in controller, while allowing the Interval Advance switch to operate.
- 6) Pedestrian and Vehicle Test switches shall be labeled "On/Off/Test" and shall be provided in each cabinet.
- a) The switches shall be installed on a vehicle and pedestrian detector test panel located on the inside of the cabinet door with the other test switches for the cabinet.
 - b) Toggle switches shall be provided for 8 vehicle and 8 pedestrian phases and wired independently to the terminal blocks.
 - c) All possible vehicle and pedestrian detector circuits shall have a separate toggle switch.
 - d) The switches shall conform to the following conditions:
 - (1) The toggle switches shall permit detection calls to be forwarded to the controller from the vehicle and pedestrian detection source for normal operation when placed in the up (On) position.
 - (2) Each toggle switch shall disconnect the vehicle and pedestrian detection source when placed in the center (Off) position. No detections shall be allowed to enter the controller when placed in this position.

- (3) The toggle switches shall place a call into the controller for the associated pedestrian or vehicular phase when placed in the down (Test) position. This position shall not be a momentary position. The switch shall be capable of being locked in Test position.
- 7) All switches shall be combined on a single panel and mounted on the inside cabinet door behind the police auxiliary panel.
- m. Surge suppressors for electrical power shall be Model HS-P-SP-120A-60A-RJ, and for telecommunications line protection shall be Model MDF 6 95V or MF 25 95V.
- 6. All mechanical relays shall have clear dust covers.
- 7. The cabinet and controller phasing shall be referenced as follows:



- a. Phase 6 shall be NB through
- b. Phase 8 shall be WB through

623 T.02.02 TRAFFIC SIGNAL CONTROLLER CABINET EQUIPMENT

- A. All traffic signal controller cabinets shall be furnished with the equipment specified below.
- B. Solid State Load Switches, Red Transfer Relays, and Sockets:
 - 1. All necessary cabinet wiring, connecting cables, terminal blocks, and sockets shall be provided for complete and proper functionality of an 8-vehicle, 4-pedestrian, and 4-overlap phase operation. A total of 16 NEMA load switches shall be provided with each cabinet.

2. Three wide-angle, high-intensity light emitting diodes (LED) of the corresponding colors RED, YELLOW, and GREEN shall be provided to indicate the status of each load switch input.
 - a. The LEDs shall be clearly visible in bright sunlight.
 - b. Refer to the latest NEMA standard publication for operational and dimensional requirements.
 3. There shall be 2 discrete NEMA flashers accompanying each cabinet.
 - a. Refer to the latest NEMA standard publication for operational and dimensional requirements.
 - b. Two wide-angle, high-intensity LEDs, clearly visible in sunlight, shall be provided for each load switch and flasher to indicate the status of each device.
 4. A minimum of 6 transfer relays shall be delivered with each cabinet.
 - a. These shall conform to the latest NEMA TS 1 specifications.
 - b. Load bay panels shall not exceed 0.125 inch of flex under 5 pounds of pressure.
- C. Pedestrian Push Button Circuit Isolation:
1. Six solid state isolation circuits shall be provided in the cabinet to separate the pedestrian detector input circuits to the controller from the pedestrian push button circuits in the field. Isolation circuits 1, 2, 3, and 4 shall correlate to signal phases 2, 4, 6, and 8, respectively, and the wiring shall be appropriately terminated within the cabinet.
 2. Circuits 5 and 6 shall be spares and shall be terminated to allow easy access from the front side of the detector panel. The Field push button circuits shall be energized by a 12 VAC source.
 3. The isolation circuits shall be mounted on an edge connector-type PC board with all required components, including the transformer and integrated circuit chips, and shall display an LED indication showing status of field buttons.
- D. Video Detection: All cabinets shall be wired for Video Detection in addition to the requirement for loop detection harnesses and equipment.
1. All cabinets shall have a discrete Video Detection Interface Panel (VDIP) installed and wired into the back-panel as appropriate.
 - a. Phases 1 through 8 and overlaps A, B, C, and D green and red outputs and 24 VDC from the controller shall be wired to the VDIP from the back panel.
 - b. The 16-vehicle and pedestrian phase detection inputs shall also be terminated on the VDIP.
 2. The VDIP shall be installed on the upper left portion of the side panel within the cabinet where the terminal blocks are easily accessible. It shall be installed to permit wiring harnesses that accompany all Video Detection Systems to be connected to these independent termination points.
- E. Loop Detection: If specified in the Contract Documents, all traffic signal cabinets shall be wired with four single-channel loop amplifier wiring harnesses and five 4-channel loop amplifier wiring harnesses.
1. Single-Channel Detectors:

- a. There shall be 1 single-channel loop amplifier with wiring harnesses for each of the phases 2, 4, 6, and 8, for advance detection with added extension operation for the through phases.
 - b. These harnesses and plugs shall conform to the latest NEMA TS 1 specifications.
 - c. The harnesses shall be wired for the loops to be used as extension loops, with each conductor independently terminated onto an individual terminal.
 - d. The Relay Common (B pin) shall terminate before continuing to logic ground.
 2. For 4-Channel Detectors:
 - a. There shall be 5 amplifiers with wiring harnesses installed and wired in the cabinet for the standard 4-channel detection unit specified in NEMA TS 1 standards, Section 11.2.28.2.
 - b. These detectors will be used for the presence detection at the intersection.
 - c. The harnesses shall be wired so the inputs of all channels are terminated directly to logic ground.
 - d. The number of detection outputs per phase shall be as indicated below with all harness wires being terminated on separate terminals.
 - 1) 4-channel Amplifier A - phases (1, 6, 6, 6)
 - 2) 4-channel Amplifier B - phases (3, 8, 8, 8)
 - 3) 4-channel Amplifier C - phases (5, 2, 2, 2)
 - 4) 4-channel Amplifier D - phases (7, 4, 4, 4)
 - 5) 4-channel Amplifier E - phases (1, 3, 5, 7)
- F. Optical Emergency Preemption:
1. All cabinets shall be equipped with encoded 3M Opticom compatible Emergency Preemption.
 2. The phase selector(s) provided shall have the capability of providing traffic signal preemption for each intersection approach individually and separately from all other phases.
 3. A minimum of 4 channels shall be provided.
 4. Unless otherwise specified in the Contract Documents, each cabinet supplied shall be wired with an Optical Emergency Preemption Panel, and shall be marked accordingly.
 - a. The panel shall have termination points for 4 preemption outputs directly wired to the discriminator.
 - b. The M138 Emergency Preemption cable coming from the Optical Detectors shall be terminated to a terminal strip located on this panel.
 5. The wiring from this panel to the back panel shall be as follows:
 - a. Channel A to Controller Plug A, Pin q.
 - b. Channel B to Controller Plug A, Pin y.
 - c. Channel C to Controller Plug B, Pin W.

d. Channel D to Controller Plug B, Pin X.

G. Supplemental 2070N D Plug Interface Panel:

1. If specified in the Contract Documents, the cabinet shall be equipped with a D panel complete with wiring harness for the D plug to be furnished with the controller.
2. The plug used for the D plug on the 2070N controller shall be an MS3116-24-61S.
3. The terminations for the harness shall have independent termination points as shown on the panel below.
4. All wiring on this panel, except for the D plug connector wiring harness itself, shall be performed by the Maintaining Agency's staff after delivery and acceptance of the controller cabinet.

H. Conflict Monitor Interface Panel:

1. Unless otherwise specified in the Contract Documents, all traffic control cabinets shall be supplied with a conflict monitor with a minimum of 12 channels.
2. If specified in the Contract Documents, an 18-channel monitor shall be supplied.
3. Twelve-channel conflict monitors shall be furnished with the program card fully programmed for standard NEMA 8-phase operation.
4. Twelve-channel monitor harnesses shall be wired in accordance with the diagram shown below.
5. Eighteen-channel conflict monitors shall be furnished unprogrammed and the harnesses shall be wired by Maintaining Agency technicians.
6. The wiring harness for the conflict monitor shall have independent termination points.
7. All conductors shall be terminated independently and separately onto a single terminal.
8. Appropriate conductors shall be landed on the back panel as necessary.
9. Unused wires shall be terminated on a separate terminal board that is easily accessible from the front of the cabinet without removing other panels.
10. There shall be no conductors hanging loose or not terminated.

I. All conflict monitors shall be NEMA standard, meeting all requirements of Section 6 of the latest edition of NEMA TS 1.

1. The conflict monitors shall also come equipped with PLUS options that are selected using dip switches or by use of the liquid crystal display (LCD) mounted on the front panel of the unit.
2. In addition, all monitors shall be equipped with the features defined below:
 - a. Conflict monitors shall be equipped with a front panel display that is menu driven.
 - 1) The display shall be LCD and shall be temperature compensated to prevent screen blackout in extreme temperature conditions.
 - 2) The LCD shall be backlit for night operation.

- b. Minimum vehicle clearance time monitoring shall be programmable and shall be available on each channel separately and independently.
- c. The LCD shall show separate indicators for activity on each of the red, amber, green, and walk inputs of each monitor channel.
- d. The LCD shall have indicators showing active channel(s), date, time, and description of the current status, while showing a log of 6 or more of the most recent failures. All such data shall be stored in a non-volatile memory.
- e. Failure status indicators shall be shown on the front panel to show the failure status for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card ajar.
- f. The monitor shall provide a front panel display of the approximate time and date of the occurrence of any power failure in excess of 500 milliseconds duration and the date and time of power restoration. The monitor program shall have computed and logged this data in non-volatile memory by the end of the power restart flash interval.
- g. All conflict monitors shall have RS-232 capability.
- h. The vendor shall supply software to interface between an IBM compatible computer and the monitor unit for downloading failure event information and other programmable events including but not limited to timing.
- i. Front panel connectors A and B mounted directly to printed circuits will not be accepted.

623 T.02.03 TRAFFIC SIGNAL CONTROLLERS

- A. Traffic signal controller assemblies shall conform to the following specifications.
- B. General:
 - 1. Controller Assemblies.
 - a. A controller assembly shall consist of a complete mechanism for controlling the operation of a traffic control signal, including the controller unit and all necessary auxiliary equipment, mounted in a traffic signal control cabinet.
 - b. All equipment required to provide the operation shown on the Drawings and specifications shall be provided.
 - 2. Flashing Operations.
 - a. All controllers shall be equipped for flashing operation of signal lights.
 - b. Flashing operations, when required by railroad preemption, flashing emergency traffic control, or other causes, shall be set for flashing red on all approaches unless otherwise specified.
 - 3. Wiring Diagrams.
 - a. A schematic diagram of the controllers and auxiliary equipment furnished under the contract shall be submitted at the time the controllers are delivered for testing or, on demand of the Engineer, prior to purchase.
 - b. This diagram shall show all circuits, all electronic elements including transistors, capacitors, inductors, resistors, integrated circuit chips, connectors and other parts in detail.

- c. All parts, materials, and equipment shall be shown by name and number in such manner as to be readily identified.
 - d. This requirement may be waived at the discretion of the Maintaining Agency.
- 4. Operating Voltage.
 - a. All equipment including interconnection facilities, and excepting pedestrian push buttons and pressure detectors, shall be designed to operate on 120 volts, 60 Hz AC.
 - b. Operation shall be satisfactory at voltages from 105 to 130.
 - c. The voltage for pedestrian push buttons shall not exceed 24 volts AC.
- 5. Tests. Prior to completion of the work, the Contractor shall cause the following tests to be made on all electrical circuits, in the presence of the Engineer:
 - a. Test for continuity of each circuit.
 - b. Visual inspection for earth and system electrical grounds in each circuit. Electrical equipment and components shall not be energized until properly grounded to the system and to earth.
 - c. A flash test for traffic signal installations to verify the terminals and connections before turn-on.
 - d. A megohmmeter test on each single conductor circuit between the circuit conductor and all other circuit and ground conductors in the conduits.
 - 1) The insulation resistance shall not be less than 500 megohms when tested at 1,000 volts for 1 minute.
 - 2) Individual conductors in traffic signal cable, other multi-conductor cables, and coaxial cables may be exempted from the megohm testing by the Maintaining Agency if a visual inspection of these cables shows no suspicious cuts, tears, or other damages to the cable or wire insulation.
 - e. A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.
 - f. Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner as directed by the Engineer, and the same test shall be repeated until no fault appears.
 - 1) After testing of each traffic signal system, the system shall be activated and required to function without failure for a period of 14 calendar days.
 - 2) Any fault or failure to the system during this period shall be corrected by the Contractor at no additional cost to the Contracting Agency, and the system will then be required to function for a period of 14 calendar days without failure.
 - 3) This procedure will continue until the system successfully operates continuously without failure for 14 calendar days.
- 6. System Turn-On.
 - a. Contractor shall not energize any traffic signal equipment without the written approval of the Engineer.

- b. The actual date and time of turn-on shall be coordinated with the Maintaining Agency.
 - c. Systems shall be permitted to be made operational only after on-site testing and certification by the Maintaining Agency.
 - d. The video detection manufacturer shall provide a technical representative at the intersection during the turn-on and testing period if required and directed by the Engineer.
 - e. The Contractor shall provide uniformed traffic control officers as required and directed by the Engineer to direct traffic during the turn-on period.
 - f. The Contractor shall immediately remove all conflicting traffic markings and signs prior to the successful turn-on of the traffic signal and dispose of all removed materials as specified in the Contract Documents.
- C. Controller Construction Specification. When a 2070N controller is supplied, the following requirements are mandated:
- 1. The 2070N controllers supplied shall conform to the latest published revision of the California Department of Transportation (CALTRANS) Transportation Electrical Equipment Specifications (TEES) requirements published at time of bid. The following configuration will apply to any controller supplied.
 - a. A 2070-7 Async Serial Comm Module shall be supplied and installed in each controller. The communications interface connection cable incorporated with the 2070-8 shall be supplied with connector DB-9S to mate with the 2070-7 module, unless otherwise directed by Drawings and specifications.
 - b. A communications modem shall be supplied in accordance with FAST system requirements. The modem shall be delivered complete with the power cord and a 5-foot DB25 to DB25 RS232 cable for connection of the EX2 connector on the 2070-8 to the DTE connector on the modem, unless otherwise specified.
 - c. Each 2070N Controller shall come equipped with a 2070-1B single-board CPU, which holds 1 MB capacitor-backed static RAM, and is equipped with an RJ45 Ethernet Communications on face plate. This port will support standard TCP/IP protocols. The module shall also contain a DB25 EIA485 serial communications port.
 - d. The controller that is provided shall be configured with a short power outage tolerance of at least 400 milliseconds without causing a CPU reset, and a minimum of 4 MB of DRAM memory, 4 MB of FLASH memory, and 512 KB of SRAM.
 - 2. The A, B, C, and D plugs shall be installed on the front of the controller with the identification letters for the Cannon plugs right-side up. The master key shall be located at the top of the plug, not the bottom.
 - 3. The 2070N Controller supplied shall, at a minimum, meet the following criteria:
 - a. Proper implementation of all TEES and the above specifications.
 - b. Successful monitoring of the operation in a test cabinet environment.
 - c. Confirmation that the LCD display and the display cover are environmentally sealed to keep dust and other particles from entering between them.

- d. Verification of operation with short power outages and momentary surges.
 - e. Verification of operation with the following provisions of software operation and compatibility.
4. All 2070N controller units shall be compatible and function properly with the latest revision of the Next Phase Intersection Management Software developed by Siemens ITS. All 2070N controller units shall be compatible and function properly with the i2tms communication package developed by Siemens ITS for the FAST Traffic Signal System, and shall be complete with all requisite hardware, cables, connectors, and related firmware for connection to and communication with the i2tms central software.
- D. Alternate (non-2070N) Controller Construction Specification:
- 1. General Description. This specification describes an advanced traffic signal controller, meeting the latest NEMA specification, as well as providing advanced features for future enhancements. This Controller shall be supplied if specified in the Contract Documents.
 - 2. Traffic signal controller shall meet or exceed all requirements of NEMA TS 2-2003.
 - a. The supplier shall provide a letter with bid from an independent testing laboratory certifying controller compliance to NEMA TS 2-2003.
 - b. A programming instruction manual shall be supplied on a CD with each controller purchased.
 - 3. The controller shall meet the Standard NEMA configuration as NEMA TS 2-2 Type 2 for direct parallel connection to load switches and detectors, fully backward compatible with NEMA TS 1 Type 1 equipment.
 - 4. In addition to NEMA requirements, the Central Processor Unit (CPU) shall provide the following:
 - a. Microware OS-9 operating system with runtime license.
 - b. Controller shall be capable of accessing OS-9 operating system via shell interface through RS-232 front panel communications port and be compatible with all NextPhase versions.
 - c. A Motorola 68360 microprocessor, 25 MHz version.
 - d. Four megabytes minimum dynamic random access memory (DRAM).
 - e. Eight megabytes minimum FLASH memory organized as a disk drive.
 - f. One megabyte minimum static random access memory (SRAM).
 - g. Time of Day (TOD) clock with hours, minutes, seconds, month, year, and automatic daylight savings time adjustment. TOD may be implemented in the CPU via electronic circuitry, operating system software, or a combination of both.
 - h. During power failures, the SRAM and TOD shall be powered by standby voltage from the power supply.
 - 5. Controller shall not require additional hardware to run NextPhase software.
 - 6. In addition to NEMA requirements, the power supply shall provide the following:

- a. Line Frequency Reference (LFR) signal shall be by crystal oscillator, which will synchronize to the 60 Hz AC incoming power at 120 degrees and 300 degrees. A continuous square wave signal shall be provided at +5 VDC amplitude, 8.333 ms half-cycle pulse duration, and 50 \pm 1 percent duty cycle.
 - b. The LFR shall compensate for missing pulses and line noise during normal operation. The LFR shall continue through 500 millisecond power interruptions.
 - c. Standby voltage will be maintained by super capacitor. No batteries of any type will be used.
- 7. In addition to NEMA requirements, keyboard and display shall provide the following:
 - a. The keypad may be removable by pulling off and installed by pushing on, without the use of tools.
 - b. If a removable keypad is provided, an extension cord will be provided to allow use of the keyboard while it is not attached to the controller. It will be stowed in an obvious and easily reachable location.
 - c. The keypad/display will be a Liquid Crystal Display (LCD) with 8 lines, 40 characters each.
 - d. LCD contrast will be adjustable.
 - e. Backlighting will be provided for the LCD.
- 8. In addition to NEMA requirements, the controller shall provide the following communications functions:
 - a. Built-in native 10 Base-T Ethernet with RJ-45 connector on controller front panel.
 - b. Built-in configurable Internet Protocol (IP) address with factory default and unique MAC address.
 - c. Built in Infra-Red (IR) wireless port.
 - d. Built in EIA-232 port for uploading and downloading applications software, as well as to update the operating system.
- 9. In addition to NEMA requirements, the controller housing shall conform to the following:
 - a. Polycarbonate construction, except back panel, rear mounting tabs, and power.
 - b. Supply mounting plate shall be aluminum for electrical grounding.
 - c. Built-in polycarbonate carrying handle.
 - d. The physical size shall not exceed 16 inches wide by 10 inches deep by 8 inches tall.
 - e. The NEMA A, B, and C plugs mounted on the front panel shall have the plug key in the upright (12 o'clock) position.
- E. The controller harnesses for connectors A, B and C shall be connected according to the following diagrams.

CONTROLLER CONNECTOR A			
Pin	Function	Pin	Function
A	Reserved	AA	Test Input B
B	+24 V DC External	BB	Walk Rest Modifier
C	Voltage Monitor	CC	Coded Status Bit A (Ring 1)
D	PH 1 Red	DD	PH 1 Phase ON
E	PH 1 Don't Walk	EE	PH 1 Ped Omit
F	PH 2 Red	FF	Ped Recycle (Ring 1)
G	PH 2 Don't Walk	GG	Max II Selection (Ring 1)
H	PH 2 Ped Clear		
J	PH 2 Walk		
K	PH 2 Veh Call Det		
L	PH 2 Ped Call Det		
M	PH 2 Hold		
N	Stop Timing (Ring 1)		
P	Inhibit Max Term (Ring 1)		
R	External Start		
S	Internal Advance		
T	Indicator Lamp Control		
U	AC- Common		
V	Chassis Ground		
W	Logic Ground		
X	Flashing Logic Out		
Y	Coded Status Bit C (Ring 1)		
Z	PH 1 Yellow		
a	PH 1 Ped Clear		
b	PH 2 Yellow		
c	PH 2 Green		
d	PH 2 Check		
e	PH 2 Phase ON		
f	PH 1 Veh Call Det		
g	PH 1 Ped Call Det		
h	PH 1 Hold		
i	Force-off (Ring 1)		
j	Ext Min Recall All PH's		
k	Manual Control Enable		
m	Call to Non Actuated I		
n	Test Input A		
p	AC+ (control)		
q	5 PPS		
r	Coded Status Bit B (Ring 1)		
s	PH 1 Green		
t	PH 1 Walk		
u	PH 1 Check		
v	PH 2 Ped Omit		
w	Omit All Red Clear (Ring 1)		
x	Red Rest Mode (Ring 1)		
y	Spare 1		
z	Call to Non Actuated II		

CONTROLLER CONNECTOR B			
Pin	Function	Pin	Function
A	PH 1 Phase Next	AA	Overlap A Green
B	*	BB	Overlap B Yellow
C	PH 2 Next	CC	Overlap B Red
D	PH 3 Green	DD	Overlap C Red
E	PH 3 Yellow	EE	Overlap D Yellow
F	PH 3 Red	FF	Overlap C Green
G	PH 4 Red	GG	Overlap B Green
H	PH 4 Ped Clear	HH	Overlap C Yellow
J	PH 4 Don't Walk		
K	PH 4 Check		
L	PH 4 Veh Call Det		
M	PH 4 Ped Call Det		
N	PH 3 Veh Call Det		
P	PH 3 Ped Call Det		
R	PH 3 Phase Omit		
S	PH 2 Phase Omit		
T	PH 5 Ped Omit		
U	PH 1 Phase Omit		
V	Ped Recycle (Ring 2)		
W	*		
X	*		
Y	PH 3 Walk		
Z	PH 3 Ped Clear		
a	PH 3 Don't Walk		
b	PH 4 Green		
c	PH 4 Yellow		
d	PH 4 Walk		
e	PH 4 Phase ON		
f	PH 4 Phase Next		
g	PH 4 Phase Omit		
h	PH 4 Hold		
i	PH 3 Hold		
j	PH 3 Ped Omit		
k	PH 6 Ped Omit		
m	PH 7 Ped Omit		
n	PH 8 Ped Omit		
p	Overlap A Yellow		
q	Overlap A Red		
r	PH 3 Check		
s	PH 3 Phase ON		
t	PH 3 Phase Next		
u	Overlap D Red		
v	*		
w	Overlap D Green		
x	PH 4 Ped Omit		
y	Spare 5		
z	Max II (Ring 2)		

*User Assigned

CONTROLLER CONNECTOR C			
Pin	Function	Pin	Function
A	Coded Status Bit A (Ring 2)	AA	PH 6 Ped Clear
B	Coded Status Bit B (Ring 2)	BB	PH 6 Check
C	PH 8 Don't Walk	CC	PH 6 Phase ON
D	PH 8 Red	DD	PH 6 Phase Next
E	PH 7 Yellow	EE	PH 7 Hold
F	PH 7 Red	FF	PH 8 Check
G	PH 6 Red	GG	PH 8 Phase ON
H	PH 5 Red	HH	PH 8 Phase Next
J	PH 5 Yellow	JJ	PH 7 Walk
K	PH 5 Ped Clear	KK	PH 7 Ped Clear
L	PH 5 Don't Walk	LL	PH 6 Walk
M	PH 5 Phase Next	MM	PH 7 Check
N	PH 5 Phase ON	NN	PH 7 Phase ON
P	PH 5 Veh Call Det	PP	PH 7 Phase Next
R	PH 5 Ped Call Det		
S	PH 6 Veh Call Det		
T	PH 6 Ped Call Det		
U	PH 7 Ped Call Det		
V	PH 7 Veh Call Det		
W	PH 8 Ped Call Det		
X	PH 8 Hold		
Y	Force-off (Ring 2)		
Z	Stop Timing (Ring 2)		
a	Inhibit Max Term (Ring 2)		
b	Spare 1		
c	Coded Status Bit C (Ring 2)		
d	PH 8 Walk		
e	PH 8 Yellow		
f	PH 7 Green		
g	PH 6 Green		
h	PH 6 Yellow		
i	PH 5 Green		
j	PH Walk		
k	PH 5 Check		
m	PH 5 Hold		
n	PH 5 Phase Omit		
p	PH 6 Hold		
q	PH 6 Phase Omit		
r	PH 7 Phase Omit		
s	PH 8 Phase Omit		
t	PH 8 Veh Call Det		
u	Red Rest Mode (Ring 2)		
v	Omit All Red (Ring 2)		
w	PH 8 Ped Clear		
x	PH 8 Green		
y	PH 7 Don't Walk		
z	PH 6 Don't Walk		

CONTROLLER CONNECTOR D			
Pins are user defined, and shall be wired			
Pin	Function	Pin	Function
A		AA	
B		BB	
C		CC	
D		DD	
E		EE	
F		FF	
G		GG	
H		HH	
I		JJ	
J		KK	
K		LL	
L		MM	
M		NN	
N		PP	
P			
R			
S			
T			
U			
V			
W			
X			
Y			
Z			
a			
b			
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e			
f			
g			
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u			
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w			
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y			
z			

623 T.02.04 MAGNETIC INDUCTION LOOP DETECTORS**A. General.**

1. The term "loop detector" applies to a complete and operating installation consisting of a loop or loops installed in the roadway in accordance with the Drawings and specifications, a sensor unit with solid state switching output, and a power source.
2. Loop detectors shall meet the requirements of and operate in accordance with the latest edition of NEMA TS 1.
3. All loop locations shall be approved by the Engineer prior to installation.
4. Loop leads shall be properly marked in the pull box and the cabinet as to the location and which vehicular phase of the traffic signal is associated with that loop.
5. A minimum of 2 feet of loop wire and 2 feet of loop lead-in shall be provided and stored in the pull box for slack.
6. All loop wires home run to pull box shall clearly identify the direction of the cables windings for ease of installation.
7. Minimum 3 turns per foot shall be provided.
8. The completed loop detector shall be capable of detecting any vehicle currently licensed by the state of Nevada.

B. Preformed Loops.

1. Loop detector wires shall be installed as preformed loop sensors when new roadways are being constructed or the existing asphalt or concrete pavement is being replaced.
 - a. The wires shall be installed in the roadway base material at least 2 inches below the concrete or below the first course of asphalt/concrete paving.
 - b. Preformed loop wires constructed specifically to be embedded directly into the subbase material or to be installed as preformed loops shall be used as shown on the Drawings.
 - c. The loop assemblies shall be properly located under the roadway in the proposed lane configuration and appropriately secured to prevent movement prior to and during the installation of the paving material.
2. Direct burial loop wires shall not be installed in road base material containing aggregate with sharp edges or aggregate larger than 1/2-inch diameter.
 - a. However, this requirement shall not prevent the installation of preformed loops.
 - b. The materials surrounding the wires shall be changed to meet this specification if necessary.
3. Preformed loop detectors shall be installed when pavement is milled 2-1/2 inches or more by cutting loop wire slots into the coarse grade of the asphalt pavement material and installing the direct-burial preformed loop wires.
 - a. The overlay material may then be applied over the embedded loop wires with the finish course to complete the installation.
 - b. These preformed loops supplied shall be as specified in the Contract Documents and approved by the Engineer.

4. Preformed loops may be required to be installed as replacements to regular loops as specified in the Contract Documents or as directed by the Engineer.
 - a. In this case, the cut in the roadway shall be made through the existing finish grade of the asphalt or concrete.
 - b. The preformed loops shall be placed in the roadway cut 2 inches below the surface of the roadway and sealed using approved loop sealant.
 5. The preformed loops shall be factory assembled.
 - a. Home runs and interconnections shall be prewired and shall be an integral part of the loop assembly.
 - b. Each loop shall be fabricated for the specific application.
 - c. All materials used in the fabrication of the preformed loops shall be flexible and shall have properties that will withstand the temperatures and pressures of paving applicators without melting, breaking, or cracking.
 6. The tee shall be constructed of heavy-duty, high-temperature synthetic rubber or high-impact glass impregnated plastic.
 - a. The minimum size of loop wire permitted shall be 18 AWG stranded copper with TFFN or XLPE insulation.
 - b. Splices are not allowed in the loop wire.
 - c. The tee shall not melt, break, or crack under the thermal and pressure conditions of the paving operations.
 - d. Preformed loop lead home run wires from the tee to the pull box shall be the same as the loop wire since splicing is not permitted.
 - e. Loop leads shall be twisted a minimum of 3 times per foot of length.
 - f. Tees shall be checked electrically for wire breaks and continuity following assembly and construction before shipment to the project site.
 7. All preformed loops and the type to be used shall be approved by the Engineer prior to installation.
- C. Cable-in-Duct System.
1. Traffic signal detection loops that are to replace existing loops or are otherwise to be placed by cutting through the finished pavement surface and that are not preformed loops shall be installed using a cable-in-duct system.
 2. The loop wires shall be installed in slots cut in the pavement and shall be oriented and sized in accordance with the Contract Documents or as directed by the Engineer.
 3. The cable-in-duct system is a loop wire encased in flexible plastic tubing.
 - a. The system shall consist of flexible plastic tubing, 1/4-inch outside diameter, surrounding a single conductor, No. 14 AWG, XHHW-2, cross-linked, polyethylene insulated loop wire.
 - b. The tubing containing the loop wire shall be installed in a 3/8-inch wide saw slot in accordance with the Uniform Standard Drawings.
 4. The flexible plastic tubing shall be Type III, Grade P33, Category 5, Class C, and shall meet the following physical dimensions:

- a. Duct Size: 0.250 inch.
 - b. Outside Diameter: 0.250 (± 0.010) inch.
 - c. Wall Thickness: 0.032 (+0)(-0.010) inch.
 - d. Nominal Inside Diameter: 0.185 inch.
 - e. Minimal Bending Radius: 1.00 inch.
5. The loop wire shall meet IMSA 51-5.
 - a. The wire shall be single conductor, No. 14 AWG copper wire with 19 strands.
 - b. The insulation shall be 15 mils of black PVC complying with UL 62 with an overall jacket of clear nylon in accordance with ASTM D4066.
 - c. The wire shall be rated for 600 volts and have a nominal OD of 0.25 inch.
 6. The cable-in-duct system shall meet the performance tests as specified in NEMA standards.
 7. Sawed slots shall be blown clean and dried prior to the installation of the loop wire.
 - a. Loop wire shall be carefully placed into the saw slot using special tools to avoid damaging the wire.
 - b. The saw cuts shall be blown clean after wire installation and before placement of sealant.
- D. Loop wire insulation shall be tested using a megohmmeter prior to the placement of loop wire sealant. Insulation resistance readings shall not be less than 100 megohms at 1,000 volts.
- E. Detector loop sealant to be used shall be approved by the Engineer prior to installation.
- F. Loop Lead-In Conductors.
1. The loop lead-in cable shall be 1 pair No. 12 AWG, tinned copper, 19 strands each in accordance with IMSA 50-2.
 2. The pair shall be twisted a minimum of 3 times per foot.
 3. Insulation on the individual wires shall be high-molecular weight polyethylene complying with ASTM D1248, clear and black.
 4. The wires shall be wrapped helically with aluminum/polyester tape applied with stranded copper drain wire.
 5. The overall insulation jacket shall be polyethylene.
 6. The cable shall be rated for 600 volts with a nominal OD of 0.376 inch.
- G. Each through lane presence and advance detection loop in the system shall have a separate lead-in cable to the controller cabinet.
1. A lead-in cable shall be provided for every 2 left turn presence loops.
 2. Each loop shall be 6 feet by 6 feet unless specified otherwise in the Contract Documents or directed by the Engineer.
- H. Detector Operational Characteristics. All loop detector amplifiers shall meet NEMA specifications and shall conform to the following requirements:
1. All detector amplifiers shall give a constant output with an open or failed loop.

2. All detectors shall be shelf mounted or rack mounted as specified in the Contract Documents.
 3. All detector amplifiers shall be equipped with a fully functional LCD that is used for both monitoring and programming.
 4. Amplifier programming shall be accomplished through the LCD.
 5. The LCD shall be backlit and shall display the complete status of the connected loop, which includes but is not limited to the loop inductance, the loop frequency, and the accumulated number of loop failure incidents.
 6. Fully functional delay/extend functions shall be incorporated into the programming.
 7. Loop amplifiers shall be equipped with a phase green override input for each detection channel.
 8. All loop amplifiers shall be capable of presence or pulse modes of operation.
 9. There shall be 1, 2, or 4 channels per each loop detector, as specified in the Contract Documents.
 10. Loop detector amplifiers shall have loop fail memory log and loop fail diagnostics.
 11. Loop detector amplifiers shall have a minimum of 4 loop frequencies and a minimum of 8 sensitivity settings including the Off position.
 12. Loop detector amplifiers shall contain solid-state components only. Relays are not allowed.
 13. Loop detector amplifiers shall be self-tuning and have complete environmental tracking.
 14. The detector amplifier shall be capable of continuous operation in a temperature range of -35 degrees F to +165 degrees F.
 15. The amplifiers shall place a permanent vehicle call to the traffic signal controller if a power interruption occurs. The unit shall retune automatically within 15 seconds after the restoration of power.
 16. The amplifiers shall not require a warm-up period prior to operation.
 17. The amplifier units shall incorporate built-in lightning protection meeting the latest NEMA Standard.
 18. All loop detector amplifiers shall have circuitry and controls for individual selection of delay or extension timing on each channel.
 19. The sensor unit power supply shall be integral to the amplifier.
- I. Cabinet Wiring for Induction Loops.
1. If single channel shelf-mount detectors are specified on the Drawings, each loop detector shown on the Drawings shall be individually wired to terminal blocks in the controller cabinet.
 2. Each loop detector amplifier shall have a standard cable harness at least 6 feet long wired to the terminal blocks.
 3. Connection to the amplifier unit shall be made using a threaded shell type connector pinned for the circuitry as shown below:

- a. For a 4-Channel Detector Amplifier: MS Connector Circuit
 - 1) A Power, Neutral, 120 VAC Power, Neutral, 120 VAC
 - 2) B Channel 4 Output, Relay Common Channel 4 Output, Source
 - 3) C Power, Line, 120 VAC Power, Line, 120 VAC
 - 4) D Channel 1 Loop Input Channel 1 Loop Input
 - 5) E Channel 1 Loop Input Channel 1 Loop Input
 - 6) F Channel 2 Loop Input Channel 2 Loop Input
 - 7) G Channel 2 Loop Input Channel 2 Loop Input
 - 8) H Chassis Ground Chassis Ground
 - 9) J Channel 3 Loop Input Channel 3 Loop Input
 - 10) K Channel 3 Loop Input Channel 3 Loop Input
 - 11) L Channel 4 Loop Input Channel 4 Loop Input
 - 12) M Channel 4 Loop Input Channel 4 Loop Input
 - 13) N Channel 1 Output, Relay Normally Open Channel 1 Output, Drain
 - 14) P Channel 1 Output, Relay Common Channel 1 Output, Source
 - 15) R Channel 2 Output, Relay Common Channel 2 Output, Source
 - 16) S Channel 2 Output, Relay Normally Open Channel 2 Output, Drain
 - 17) T Channel 3 Output, Relay Common Channel 3 Output, Source
 - 18) U Channel 3 Output, Relay Normally Open Channel 3 Output, Drain
 - 19) V Channel 4 Output, Relay Normally Open Channel 4 Output, Drain
- b. For a Single Channel Detector Amplifier: MS Connector Circuit
 - 1) A 120-volt (AC grounded conductor)
 - 2) B Relay Contact Common (Output Negative)
 - 3) C 120-volt (AC line)
 - 4) D Loop
 - 5) E Loop
 - 6) F Relay Contact (Output Positive) N.C.
 - 7) G Relay Contact, Open for Call
 - 8) H Chassis Ground
 - 9) I Spare
 - 10) J Spare

J. Slot Sealant Tests and Acceptance.

- 1. Insulation Test. Insulation tests for each loop to ground shall be in accordance with the latest edition of NEMA TS 1.
- 2. Sensitivity Test. The completed loop detector shall be capable of detecting any vehicle currently licensed by the state of Nevada.

K. Installation of Inductive Detector Loop Sealant.

1. Detector loop sealant shall be either:
 - a. A 2-component epoxy or a polyurethane material that cures in the presence of moisture and conforms to the following specifications.
 - b. A hot-melt, rubberized asphalt material conforming to the following specifications.
2. Sealant shall be suitable for use in both asphalt concrete and Portland cement concrete pavements.

TWO COMPONENT EPOXY COMPOSITION

Parts by Weight	
Component A:	
Epoxy Resin, Araldite 6010	100
Nonyl Phenol	20
Alkylbenzene, Alkylate 31	20
Titanium Dioxide, Titanox 2015	1.62
Colloidal Silica, Cabosil	3
Glycerine	0.5
Silicone Anti-foam, G.E. Viscasil	0.01
Component B:	
Poly Mercaptan, Dion 3800 L C	40
N-Aminoethylpiperazine	17
2,4,6 - Tri (dimethylaminomethyl) Phenol	2
Furnance Black	0.03
Nonyl Phenol	34.6
Alkylbenzene, Alkylate 31	34.6
Colloidal Silica, Cabosil	4
Glycerine	0.5
Silicone anti-foam, G.E. Viscasil	0.01
Characteristics of Adhesives:	
Component A:	
Viscosity, Poise, Brookfield	150-300
Shear Index	2.5 minimum
Component B:	
Viscosity, Poise, Brookfield	100-250
Shear Index	2.0 minimum
Characteristics of Compounded Adhesive:	
Gel Time, Minutes	13 to 16
On 1/8 inch cast sheet, cured 18 hours at 77 degrees F plus 5 hours at 158 degrees F	
Tensile Strength Minimum	700 psi
Elongation, Percent, Minimum	70

TWO COMPONENT EPOXY COMPOSITION**Parts by Weight**

Shore D Hardness, Minimum 50

Color shall match Federal Standard No. 595;
color range shall be 26081 to 26173**POLYURETHANE SEALANT****Property and Results****Measuring Standard and Conditions**

Hardness (indentation) — 65-85

ASTM D2240 Rex Type A, Model 1700

77 degrees F, 50 percent relative humidity

Tensile Strength — 500 psi (minimum)

ASTM D412 Die C, pulled at 20 ipm

Elongation — 400 percent, minimum

ASTM D412 Die C, pulled at 20 ipm

Flex at -40 degrees F — no cracks

25 mil free film bend over 1/2-inch mandrel

Weathering Resistance — Slight Chalking

ASTM D822 Weatherometer 350 hours

Cured 7 days at 77 degrees F

50 percent relative humidity

Salt Spray Resistance — 500 psi,
minimum tensile; 400 percent minimum
elongation

ASTM B117, 28 days at 100 degrees F

5 percent NaCl, Die C, pulled at 20 ipm

Dielectric Constant — Less than
25 percent change over a temperature
of -22 degrees F to 122 degrees F

ASTM D150

Chemical Resistance: Chemical and Results**Test Method**

De-Icing Chemical — No Effect

ASTM D471

Gasoline — Slight Swell

ASTM D471

Hydraulic Brake Fluid — No Effect

ASTM D471

Motor Oil — No Effect

ASTM D471

Calcium Chloride (5 percent) — No Effect

ASTM D471

Tests conducted on deaerated, 0.020 inch, dry film liquid immersion; 28 days at 77 degrees F

HOT-MELT, RUBBERIZED ASPHALT SEALANT**Property and Limits****Measuring Standard and Conditions**

Cone Penetration — 20 - 35 (1/10 mm.) max.

ASTM D5,

77 degrees F, 150 g, 5 sec

Flow -- 5 mm. maximum

ASTM D5329, Section 6, 140 degrees F

Resilience --60% minimum

ASTM D6690, 77 degrees F

Softening Point — 200 degrees F

ASTM D36

Ductility -- 30 - 55 centimeters

ASTM D113,

77 degrees F, 5 cm/sec

Flash Point --575 degrees F

ASTM D92, COC

Viscosity -- 2,500 - 3,500 centipoises
(Brookfield)

ASTM D3236

375 degrees F

623 T.02.05 EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM (INTERNAL PREEMPTION)**A. General Emergency Vehicle Detection System Description.**

1. The Priority Control System shall consist of a data-encoded optical emitter, optical detectors, optical detector cable, and priority control unit.
2. The system shall employ data-encoded optical communications to identify the presence of designated priority vehicles, cause the traffic signal controller to initiate a specific preprogrammed preemption procedure, and record the vehicle by classification and identification number.
 - a. The matched set of components that make up the system shall cause the existing traffic controller to be manipulated upon recognition of the signal from the vehicle.
 - b. The vehicle communication is provided to the controller by the optical detectors at or near the intersection which receives a pulsating light from the vehicle over a line-of-sight path.
3. The system shall require no action of the vehicle operator other than the operation of the emitter switch located in the vehicle. The vehicle operator leaves the switch in the ON position until the vehicle passes the targeted traffic signal.
4. The system shall interface with existing traffic signal controllers without compromising normal operation or existing safety provisions.
 - a. The system shall operate on a first-come, first-served basis or on a selected priority.
 - b. The higher priority requests will override lower priority requests.
 - c. The system shall be designed to yield to other priority demands such as railroads.

B. Matched System Components.

1. To ensure desired performance, the system shall provide the synergy of the 4 principal components, matched and proven through integrated testing and extensive functional experience.
2. The matched component system shall offer compatibility with all types of traffic signal controllers and shall provide future compatibility of all priority control elements.
3. Data-Encoded Optical Emitter. Shall be a compact, lightweight, weatherproof, light-emitting device with internal, regulated power supply designed to produce high intensity optical energy in visible and infrared wavelengths as well as encoded pulses that carry vehicle class and ID number information, from a single source, precisely timed by a crystal controlled circuit.
4. Optical Detector.
 - a. Shall be a lightweight, weatherproof, adjustable, bidirectional optical detector assembly.
 - b. Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1,000 feet) via optical detector cable to the priority control unit.
5. Optical Detector Cable. Shall be a durable, shielded, 3-conductor cable with a drain wire and the necessary electrical characteristics to carry power to the optical

detector from the priority control unit and to carry the optical detector signal to the priority control unit.

6. Priority Control Unit. This equipment shall provide interface between the optical detectors and the traffic signal controller unit and shall comply with the following while not compromising the existing fail-safe provisions:
 - a. Provide sufficient power to all optical detectors required for the intersection.
 - b. Differentiate optical detector signals from 1 or more emitters on a first-come, first-served basis.
 - c. Provide output signals to the traffic signal controller to cause a preemption sequence to display the desired phase green for the approaching emergency vehicle.
 - d. All input and output wires of the priority control system shall be terminated on a separate panel before being wired to the controller back panel.
 - e. Assist the traffic signal controller in providing a smooth transition to non-priority operation after the passage of the emergency vehicle through the intersection.
 - f. Store up to 100 of the most recent priority control calls in non-volatile memory and retain the record if power terminates.
- C. System Operation. The emergency vehicle preempt system shall operate in accordance with the following:
 1. Priority control system shall be activated by an optically transmitted signal capable of recognizing and discriminating an Optical Emitter flash rate of Class I 9.63855 Hz ± 0.0014 Hz or Class II 14.0359 Hz ± 0.0039 Hz from a single light source or upon the actuation of a test switch or remote call signal to the phase selector. The system shall cause the traffic controller to select the green phase associated with the approaching emergency vehicle and place a priority call to initiate that phase.
 2. The system shall not require modification or replacement of the existing controller unit beyond adding the necessary system hardware.
 3. The system shall not cause the traffic signal controller to skip vehicular change or clearance intervals.
 4. The system shall be capable of accepting emergency preempt calls from all approaches to the intersection independently without modification or replacement of the existing phase selector unit.
 5. The system shall maintain adequate minimum traffic signal displays when priority control is active and all traffic signal display indications and sequences shall conform to the MUTCD.
 6. The system shall provide for up to 3 optical detectors to be connected to each channel.
 7. The system shall allow the traffic signal controller to resume normal timing operation after the preempt clears.
 8. The system shall not attempt controller manipulation nor retain priority vehicle calls during periods of Intersection Flash operation.
- D. System Component Specification. System components shall conform to the following:
 1. Data-encoded Optical Emitter.

- a. The flash signal shall consist of a frequency base signal and a coded overlay signal that can be used to transmit information.
 - b. The flash sequence generated by the data-encoded emitter shall carry 3 types of information:
 - 1) The base frequency as established in Subsection [623 T.02.05.C](#) "System Operation," subparagraph 1.
 - 2) The vehicle classification and identification code. The data-encoded emitter shall be capable of setting a minimum of 10 different classifications with 1,000 different identification numbers per class for each priority.
 - 3) Intersection detection range setting.
 - c. The data-encoded emitter will conduct self-diagnostics designed to check for missing pulses.
 - d. The data-encoded emitter will be equipped with a disable input that, when activated, will cease unit operation, thereby eliminating the possibility of inadvertent signal transmission after the priority vehicle has arrived at its destination.
2. Optical Detector.
- a. The optical detector shall be a lightweight, weatherproof device capable of sensing and transforming pulsed optical energy into electrical signals usable by the phase selection equipment.
 - b. The unit shall be high-impact polycarbonate construction with non-corrosive hardware.
 - c. The unit shall be designed for simple mounting at or near an intersection on mast arm, pedestal, pipe, or traffic signal.
 - d. The unit shall accept optical signals from all approaches to the intersection independently without modification or replacement of the existing phase selector unit.
 - e. The unit shall include a design feature to allow aiming of the 2 optical sensing inputs for skewed approaches or slight curves, and may be field verified.
 - f. The unit shall be responsive to the optical emitter at a distance of 1,800 feet.
 - g. The unit shall be capable of providing the necessary electrical signal to the priority control unit (phase selector) through up to 1,000 feet of optical detector cable.
3. Optical Detector Cable.
- a. The cable shall deliver the necessary signal from the optical detector to the phase selector over a maximum distance of 1,000 feet.
 - b. The cable shall be three No. 20 AWG (minimum gauge) stranded copper conductors and 1 bare ground wire.
 - c. The individual conductors shall be tinned copper and shall be color coded as follows:
 - 1) Orange for delivery of optical detector power (+).
 - 2) Bare for optical detector neutral (-).

- 3) Yellow for optical detector signal.
 - 4) Blue for a second optical detector signal.
 4. Priority Control Equipment (Phase Selector). The Emergency Vehicle Priority Control or Phase Selector shall be a self-contained stand-alone unit that shall recognize input signals from separate preempt channels for all traffic signal approaches and shall contain the following major parts:
 - a. Card Rack:
 - 1) The power supply shall be contained in a card rack.
 - 2) The power supply shall be powered from AC mains in the traffic signal cabinet, and shall supply power to the Optical Detectors.
 - 3) Plug-in card edge connectors and appropriate plugs and harnesses shall be used to connect the card rack unit to the cabinet wiring assembly.
 - b. Priority Control Discriminator Plug-in Module:
 - 1) This module unit shall either be a single plug-in 4-channel device or 2 plug-in 2-channel devices, as specified in the Contract Documents or directed by the Engineer, designed to be used with optical Emitters and Detectors.
 - 2) The unit shall be capable of recognizing and discriminating Optical Emitter flash rates as described in Subsection [623 T.02.05.C](#) "System Operation," subparagraph 1.
 - 3) The unit shall be capable of recognizing and distinguishing data-encoded optical signals and shall meet the following requirements:
 - a) Programming and retrieving the data stored shall be accomplished using an IBM PC-compatible computer. Unit shall have the capability of storing 100 of the most recent calls. Each record entry shall include information as follows:
 - (1) Vehicle Classification.
 - (2) Vehicle Identification Number.
 - (3) Vehicle Priority level.
 - (4) Vehicle Direction.
 - (5) Call Duration.
 - (6) Final green indications at the end of the preempt call.
 - (7) Duration of final green indications.
 - (8) Time date and duration of the call.
 - b) Unit shall be capable of 3 levels of discrimination of data-encoded optical signals as described elsewhere in this specification.
 - c) Interface with the cabinet shall be wired as described elsewhere in this specification.- E. Reliability. All equipment supplied as part of the optical priority remote traffic control system intended for use in the traffic signal controller cabinet shall meet the electrical and environmental specifications contained in the latest edition of the NEMA standards.

623 T.02.06 TRAFFIC SIGNAL VIDEO IMAGE DETECTION SYSTEMS

- A. Video detection systems shall be as specified in the Contract Documents or equal as approved by the Engineer.

623 T.02.07 SYNCHRONIZING CLOCK

- A. Unless otherwise specified in the Contract Documents, all controllers shall be supplied with a highly accurate synchronizing clock that maintains time by referencing signals that are broadcast from Global Positioning System (GPS) satellites.
- B. The timing device shall be provided on an integrated circuit card format that slides easily into the rack of a 2070 traffic signal controller.
 - 1. The timing device shall have the same footprint as the ATC/2070-7x and shall be capable of accuracy to within 10 milliseconds of the GPS data stream.
 - 2. The timing device shall be an output only device and shall not receive commands from the controller.
 - a. The time shall be updated every minute on the minute so that the controller maintains an accurate time of day and is referenced every minute to the GPS control.
 - b. Time zone and daylight savings shall be selected by means of an 8-position dipswitch on the circuit board.
- C. A signal status LED indicator shall be provided on the front panel of the timing device that shows the status of the clock signal. The LED indicator shall display the accuracy of the clock.
- D. Windows based software shall be provided with the timer that can be used for training, system configuration, and device testing.
- E. A small GPS antenna shall be provided that mounts on top of the control cabinet and connects to the circuit card for enhanced signal reception.
 - 1. The connecting coaxial cable shall be 6 feet in length.
 - 2. The antenna shall be mounted on the controller cabinet where there is a clear view of the sky to facilitate adequate linkage with satellite signals.

TRAFFIC SIGNALS AND FITTINGS**623 T.02.08 VEHICLE SIGNAL FACES**

- A. All vehicle signal faces shall consist of individual signal sections rigidly fastened together.
 - 1. Each section shall have a separate and complete housing.
 - 2. The actual number and type of sections shall be shown on the Drawings and in accordance with the *Manual on Uniform Traffic Control Devices* (MUTCD) and the Uniform Standard Drawings (USD).
 - 3. Vehicle signal face shall be installed as indicated on the Drawings.
 - 4. All vehicle signal faces shall be mounted onto their supports by mounting assemblies in accordance with the Uniform Standard Drawings.
- B. All new vehicle signal faces installed at any one intersection shall be the product of the same manufacturer.

- C. Traffic signal indications that have been installed and are not in operation shall be covered from public view in accordance with Subsection [623 G.03.03](#), "Scheduling of Work," to clearly show that the signals are inoperative.
- D. Optical Units:
1. Optical units for vehicular traffic signals shall be LED modules and shall be interchangeable with all traffic signal head manufacturers.
 2. The LEDs shall be securely fastened to a printed circuit board and shall meet FCC Title 47, Subpart B, Section 15 Regulations for electrical noise.
 3. The LED module shall be watertight when properly mounted in the signal head enclosure and conform to NEMA and Institute of Transportation Engineers (ITE) moisture resistance standards. The modules shall specifically conform to the NEMA 250 moisture resistance standards for Type 4 enclosures.
 4. ALL LED modules shall be operationally compatible with NEMA TS 1 and NEMA TS 2 conflict monitoring parameters.
 5. All indications shall conform to the most recent edition of the ITE publication "Vehicle Traffic Control Signal Heads - Light Emitting Diode Circular Signal Supplement" (VTCSH-LED), adopted by reference into the MUTCD. The modules shall be certified by independent testing lab that they meet the VTCSH-LED specification.
 6. All vehicular LED modules shall reach 90 percent of full illumination within 110 milliseconds of the application of the nominal voltage and shall cease emitting visible illumination within 110 milliseconds of the removal of the nominal operating voltage.
 7. The LED module circuitry shall prevent flicker of the LED output at frequencies less than 100 Hz over the operating voltage range. There shall be no visible illumination from the LED module when the applied voltage is less than 35 VAC.
 8. The LED modules for vehicle signal control shall be 12 inches in diameter. They shall be complete individual units, consisting of plastic tinted lenses (red, yellow, or green) made of ultraviolet stabilized polycarbonate, an LED circuit board inclusive of all individual LEDs and required circuit components, a minimum 39-inch 18 AWG color-coded wire leads with strain relief and female quick connect/fasten terminals for 18 AWG wire, and a 1-piece commercial grade neoprene gasket.
 9. The LED modules shall be connected directly to line voltage, 117 VAC nominal, and shall operate over the voltage range of 80 VAC to 135 VAC, with a power factor exceeding 0.90.
 - a. Total harmonic distortion shall be 20 percent or less.
 - b. The intensity of the LED signal shall not vary by more than 10 percent over the allowable voltage range.
 10. The failure of any one LED in ball modules shall not cause the loss of more than 2-1/2 percent of lens surface illumination, nor more than 1 percent of the entire module luminosity.
 11. Lenses for LED modules shall incorporate facets that serve to enhance the optical efficiency of the LED traffic signal module.
 - a. Facets shall be arranged on the inside of the lens.
 - b. External lens facets are not allowed.

- c. The LED lens shall reduce glare and sun reflection.
 - 12. The housing of the LED vehicular signal module shall be marked "TOP" to designate the proper orientation of the module in the traffic signal housing and shall be marked with a color-coded symbol to identify the color of the LED module. In addition, all arrow indications shall designate the orientation by a label affixed to the assembly.
 - 13. All LED vehicular indications shall produce the appearance of an incandescent traffic signal indication.
 - a. The illuminated surface of each LED ball indication shall appear to the motorist as uniform and shall have a wide viewing angle that makes it suitable for installation on wide roadways.
 - b. Individual LED arrays shall not be visible separately for these indications but shall light the surface of the tinted lens uniformly to make the indication appear to be illuminated by incandescent lamps.
 - 14. Manufacturer Warranty:
 - a. The manufacturer's warranty of all LED modules shall be minimum 5-year replacement of any defective or failed LED units from the time of activation.
 - b. The manufacturer shall further warranty all LED modules for a minimum life of 5 years for compliance with minimum illumination output from date of acceptance.
 - c. The manufacturer shall be responsible for all pickup or shipping costs for the replacement units.
- E. Housing.
- 1. Each signal section housing shall be either die-cast or permanent mold-cast aluminum conforming to ANSI Standard C-10.1.
 - 2. Maximum height of a signal section shall be 10 inches for each 8-inch section and 14-1/16 inches for each 12-inch section.
 - 3. Each section shall be complete with a 1-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and a simple door-locking device.
 - 4. The optical system shall be mounted for ready access and removal.
 - 5. The sections shall be interchangeable and so constructed that sections can be removed and added.
 - 6. There shall be an opening in the top and bottom of each section to receive a 1-1/2-inch pipe.
 - 7. All bolts, screws, hinge pins, door-locking devices, and other hardware shall be stainless steel.
 - 8. All gaskets shall be of neoprene.
 - 9. Each signal section shall be constructed so that structural failure of the housing will not occur with a wind load pressure of 25 pounds per square foot on the projected area of the complete signal face housing, including backplate and visors.

10. Any fracture within the housing assembly or a deflection of more than half the lens diameter of the signal section will be considered structural failure.
- F. Electrical Components.
1. Traffic signal section wiring shall conform to ANSI Standard D-10.1.
 2. Each LED module shall be wired to a terminal block mounted inside at the back of the signal housing.
 3. The terminal block shall have sufficient screw-type terminals to terminate all field conductors independently with separate screws.
 4. The terminals to which field conductors are attached shall be permanently identified or conductors shall be color coded to facilitate field wiring.
- G. Visors. Each section shall be provided with a removable, full-circle, metal visor conforming to ANSI Standard D-10.1 and the Uniform Standard Drawings, unless otherwise shown on the Drawings.
- H. Directional Louvers.
1. Where shown on the Drawings, directional louvers shall be furnished and installed in signal visors.
 2. Directional louvers shall be so constructed as to have a snug fit in the signal visors.
 3. The outside cylinder shall be constructed of 0.030-inch nominal thickness or thicker sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of equivalent thickness.
 4. Dimensions of louvers and arrangements of vanes shall be as shown on the Drawings.
- I. Backplates.
1. Backplates shall be furnished and installed on all vehicular signal heads.
 2. Dimensions, materials, and installation details shall be as shown in the Uniform Standard Drawings No. 900 through No. 903.
 3. No background light shall show between the backplate and the signal face or between sections.
 4. Where a backplate consists of 2 or more sections, the section shall be fastened with rivets or with aluminum bolts peened after assembly to prevent loosening.
 5. All traffic signal backplates shall be louvered and shall be painted or powder coated flat black using the same technique as on the signal housing.
- J. Signal Mounting Assemblies.
1. Assemblies for the mounting of signal faces shall consist of 1-1/2-inch standard steel pipe and necessary fittings, slip-fitters, and terminal compartments painted or powder-coated using the same technique and the same color as on the signal housing.
 - a. All post top and side mount brackets shall have bronze or ferrous terminal compartments.
 - b. Each terminal compartment shall be fitted with a terminal block containing a minimum of 12 poles, each with 2 screw-type terminals.
 - c. Each terminal shall be designed to accommodate at least five No. 14 AWG conductors.

- d. A cover shall be provided on the compartment to give ready access to the terminal block.
- 2. Bracket-mount terminal compartments shall be designed to bolt securely to a pole.
 - a. The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches, except where required to provide proper signal face alignment or permit programming of programmed visibility signal faces or when otherwise directed by the Engineer.
 - b. Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway.
 - c. All mounting assembly members shall be either plumb or level, symmetrically arranged, and securely assembled.
 - d. All conductors shall be concealed.
 - e. Mounting assemblies shall be watertight and free of sharp edges or protrusions that might damage conductor insulation.
- 3. Post-top mounted signals shall be installed using a slip-fitter.
 - a. The slip-fitter shall fit over a 4-1/2-inch outside diameter pipe or tapered standard end.
 - b. Each slip-fitter shall be provided with 3 cadmium-plated or stainless steel set screws evenly arranged around the fitting.
 - c. Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment.
- 4. Side mount assemblies shall be attached to the signal pole in accordance with Uniform Standard Drawings No. 404.1024 and No. 404.1029.
- 5. All mounting assemblies shall be provided with positive locking, serrated fittings that, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees.

623 T.02.09 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES

- A. Each programmed visibility signal face and the installation thereof shall conform to Subsections [623 T.02.08.I](#), "Backplates," and [623 T.02.08.J](#), "Signal Mounting Assemblies."
- B. Each programmed visibility signal section shall provide a nominal 12-inch solid or arrow indication.
 - 1. Color and arrow configuration shall conform to ANSI Standard D-10.1.
 - 2. Each section shall be provided with a sun visor.
- C. All signal sections shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings.
 - 1. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments.
 - 2. The signal shall be mountable with ordinary tools and capable of being serviced without tools.

3. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified.
- D. The visibility of each programmed visibility signal face shall be capable of adjustment or programming within the face. When programmed, each signal face's indication shall be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side will be permissible.
- E. Prior to programming, each signal section with a yellow indication shall provide a minimum luminous intensity of 3,000 candela on the optical axis, and a maximum intensity of 30 candela at 15 degrees horizontal from the axis.
 1. Each such signal section shall be capable of having its visibility programmed to achieve the following luminous intensities:
 - a. A minimum of 3,000 candela on the optical axis.
 - b. A maximum of 100 candela at from 1/2 degree to 2 degrees horizontal from the axis.
 - c. A maximum of 10 candela at from 2 degrees to 15 degrees horizontal from the axis.
 2. Under the same conditions, the intensities of the red indication and the green indication shall be at least 19 and 38 percent respectively of the yellow indication.
- F. Each signal face or each signal section shall include integral means for regulating its luminous intensity between limits in proportion to the individual background luminance.
 1. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1,000 foot-candles, and shall reduce to 15 \pm 2 percent of maximum intensity at less than 1 foot-candle.
 2. The dimming device shall operate over an applied voltage range of 95 volts to 130 volts, 60 Hz and a temperature range of -40 degrees F to 165 degrees F.
- G. The Contractor shall have a manufacturer's representative program the heads.

623 T.02.10 PEDESTRIAN SIGNAL FACES

- A. Each pedestrian signal face shall conform to the following:
 1. Messages shall be Lunar White WALKING PERSON and Portland Orange COUNTDOWN conforming to the requirements of the *Manual on Uniform Traffic Control Devices*.
 2. Each pedestrian signal face shall be installed at the location and mounted in the manner shown on the Drawings.
 3. All new pedestrian signal faces installed at any one intersection shall be of the same make and manufacturer.
 4. Pedestrian signal indications that have been installed and are not in operation shall be covered from public view in accordance with Subsection [623 G.03.03](#), "Scheduling of Work," to clearly show that the signals are inoperative.
 5. Pedestrian signals may be temporarily turned so that the faces are not visible to pedestrians if approved by the Engineer.
- B. Optical Units.

1. Optical units for pedestrian signals shall be LED modules and shall be interchangeable with all pedestrian signal head manufacturers.
2. The LEDs shall be securely fastened to a printed circuit board and shall meet FCC Title 47, Subpart B, Section 15 Regulations for electrical noise.
3. The LED module shall be watertight when properly mounted in the signal head enclosure and conform to NEMA and ITE moisture resistance standards. The modules shall specifically conform to the NEMA 250 moisture resistance standards for Type 4 enclosures.
4. ALL LED modules shall be operationally compatible with NEMA TS 1 and NEMA TS 2 conflict monitoring parameters.
5. The LED module circuitry shall prevent flicker of the LED output at frequencies less than 100 Hz over the operating voltage range. There shall be no visible illumination from the LED module when the applied voltage is less than 35 VAC.
6. The LED modules for pedestrian signals shall be 17 inches wide and 16 inches high.
 - a. LED modules shall be complete units, consisting of clear, textured and stabilized polycarbonate lenses, an LED circuit board inclusive of all individual LEDs and required circuit components, a 39-inch No. 18 AWG color-coded wire leads with strain relief and female quick connect/fasten terminals for No.18 AWG wire, and a one-piece commercial grade neoprene gasket.
 - b. The LEDs shall be securely fastened to a printed circuit board and shall meet FCC Title 47, Subpart B, Section 15 Regulations for electrical noise.
7. LED modules shall have textured lenses to reduce glare.
8. The COUNTDOWN LED modules shall utilize exclusively AS or TS ALnGaP technology. The PERSON LED modules shall utilize InGaN technology.
 - a. LED modules shall not exhibit degradation of more than 30 percent of their initial light intensity following accelerated life testing (operating at 185 degrees F and 85 percent humidity for 1,000 hours).
 - b. LED modules shall be connected directly to line voltage, 117 VAC nominal, and shall operate over the voltage range of 80 VAC to 125 VAC, with a power factor of 0.90 or better.
 - c. Total harmonic distortion shall be 20 percent or less.
 - d. The intensity of the LED signal shall not vary by more than 10 percent over the allowable voltage range.
9. Each individual LED module shall have a separate power source for the WALKING PERSON and COUNTDOWN indications internal to the module.
10. The LED modules shall be energy efficient.
11. Unless otherwise specified, the LED modules shall include a countdown indication as specified in the most recent MUTCD requirements.
12. Manufacturer Warranty:
 - a. The manufacturer's warranty of all LED modules shall be minimum 5-year replacement of any defective or failed LED units from the time of activation.

- b. The manufacturer shall further warrantee all LED modules for a minimum life of 5 years for compliance with minimum illumination output from date of acceptance.
- c. The manufacturer is responsible for all pickup or shipping costs for the replacement units.

C. Housing.

1. The housing shall be made of 3003 H14 die cast aluminum alloy with smooth finish on both sides.
 - a. Thickness shall be 1/8-inch minimum at the points of support.
 - b. The housing shall be corrosion resistant and shall provide for easy access to and replacement of all components.
 - c. All machine screws, studs, and washers shall be either nickel plated brass, stainless steel, or other corrosion resistant material.
 - d. Gaskets shall be provided as required to make the housing rain-tight and dust tight.
 - e. Gaskets shall conform to the provisions in ASTM D1056, Grade SBE42.
2. The housing shall be provided with top and bottom openings for 1-1/2-inch pipe.
 - a. Unused openings shall be closed with watertight closures painted to match the housing, as shown on the Uniform Standard Drawings.
 - b. The housing construction design shall not incorporate a clamshell mounting.
 - c. The housing shall be fully adjustable.
3. Terminal Block: A light duty terminal block shall be mounted in the housing for field wiring.
4. Finish: The outside of the housing shall be painted the same color using the same painting process as for the vehicular signals.
5. Pedestrian Signal Mounting Assemblies:
 - a. Assemblies for the mounting of pedestrian signals shall consist of 1-1/2-inch standard steel pipe and necessary fittings, slip-fitters, and terminal compartments painted or powder-coated using the same technique and the same color as on the signal housing.
 - b. All post top and side mount brackets shall have bronze or ferrous terminal compartments.
 - 1) Each terminal compartment shall be fitted with a terminal block containing a minimum of 6 poles, each with 2 screw-type terminals.
 - 2) Each terminal shall be designed to accommodate at least five No. 14 AWG conductors.
 - 3) A cover shall be provided on the compartment to give ready access to the terminal block.
 - c. Bracket-mount terminal compartments shall be designed to bolt securely to a pole.

- 1) The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches, except where required to provide proper pedestrian signal face alignment.
 - 2) Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway.
 - 3) All mounting assembly members shall be either plumb or level, symmetrically arranged, and securely assembled.
 - 4) Construction shall permit all conductors to be concealed.
 - 5) Mounting assemblies shall be water-tight and free of sharp edges or protrusions which might damage conductor insulation.
- d. Post-top mounted pedestrian signals shall be installed using a slip-fitter.
- 1) The slip-fitter shall fit over a 4-1/2-inch outside diameter pipe or tapered standard end.
 - 2) Each slip-fitter shall be provided with 3 cadmium-plated or stainless steel set screws evenly arranged around the fitting.
 - 3) Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment.
- e. All mounting assemblies shall be provided with positive locking, serrated fittings that, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees.

623 T.02.11 PEDESTRIAN PUSH BUTTONS

- A. Pedestrian push buttons of tamper-proof construction shall be furnished and installed for all pedestrian phases. The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather condition.
- B. The pedestrian push button switch shall be a phenolic, enclosed, precision snap-acting type switching unit. It shall be single-pole, double-throw, with screw-type terminals, rated 15 amperes at 125 VAC, and shall have the following characteristics:
1. The switching unit shall have a stainless steel plunger actuator.
 2. The switch shall be provided with U-frame to permit recessed mounting.
 3. The switch shall have an operating force of 0.56 to 0.81 lbf and have a minimum release force of 0.25 lbf.
 4. Switch pre-travel shall be 1/64 inch maximum.
 5. Switch over-travel shall be 7/32 inch minimum.
 6. Switch differential travel shall be 0.0004 to 0.002 inch.
- C. Push buttons shall be 2-inch minimum diameter.
- D. Pedestrian push button housings attached to poles shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

- E. Pedestrian push buttons to be mounted on top of a 2-1/2-inch diameter post shall incorporate a slip-fitter coupling with recessed set screws for securing the mechanism rigidly to the post.
- F. Push button and sign shall be installed on crosswalk side of the pole.
- G. Arrows on push button sign shall point in same direction of corresponding crosswalk.
- H. Mounting height of the pedestrian push button shall be in accordance with the latest published edition of the ADA Guidelines.
- I. Pedestrian push button signs shall be designated on the Drawings.

623 T.02.12 FLASHERS

- A. All flasher signal heads shall be a minimum 12-inch diameter lens.
- B. Visors. Each flashing beacon shall be provided with a tunnel type visor.
- C. Flashing Beacon Control Assembly.
 - 1. Each flashing beacon control assembly shall consist of switches, circuit breakers, terminal blocks, flasher, wiring, and electrical components necessary to provide proper operation of the beacons, all housed in a single enclosure.
 - 2. The enclosure shall be as specified in the Uniform Standard Drawings or Special Provisions.
- D. Circuit Breakers and Switches.
 - 1. A single-pole 15-ampere circuit breaker shall be installed to control each ungrounded conductor entering the enclosure.
 - 2. A switch to permit manual operation and testing of the flasher circuit shall be provided and labeled "Auto-Test."
 - 3. The switches shall be toggle type, single-pole, single-throw, and rated at 15 amperes, 125 VAC.
 - 4. Switches shall be connected in parallel with the timing control circuit so that the timer is bypassed when the switch is in the Test position.
- E. Flasher. A 15-ampere solid state flasher shall provide for a 2-circuit alternate operation of beacons.
- F. Terminal Blocks. Terminal blocks shall be rated at 25 amperes, 600 volts, shall be molded from phenolic material, and shall be the barrier type with plated brass screw terminals and integral type marking strips.

623 T.02.13 TRAFFIC SIGNAL POLES

- A. All traffic signal poles shall consist of a continuous tapered rounded or multi-sided steel pole shaft of the length specified, pole cap, anchor bolt cover, and hand hole cover(s), with the bolts, nuts, and washers necessary to complete the installation of the pole shaft.
- B. The traffic signal and luminaire mast arms shall consist of continuous, tapered round steel tubes of the lengths specified, mast arm end caps and bolts, nuts, and washers necessary to complete the installation of the mast arms.

- C. Pole assemblies, traffic signal mast arms, luminaire mast arms and brackets, anchor-bolt and handhole covers, and pole and mast arm caps shall be hot-dip galvanized in conformance with ASTM A123.
 - 1. Associated hardware shall be hot dip galvanized in accordance with ASTM A153.
 - 2. Flaws in the appearance of galvanized components shall be cause for rejection by the Engineer.
 - 3. The Engineer shall reject galvanized materials with finishes that have a striped or uneven appearance, a build-up of zinc hydroxide, rust stains, ash inclusions, dross protrusions, and/or flux inclusions.
 - 4. Galvanized materials that exhibit these flaws shall also be rejected.
- D. Anchor-bolt covers shall be a two-piece aluminum or ferrous metal design with a finish to match the pole shaft.
 - 1. Anchor bolt covers shall cover the base plate completely and shall be firmly secured in place at the bottom of the pole.
 - 2. Anchor bolt covers for traffic signal poles shall rest on the top of the foundation when installed properly but shall not exceed 6 inches in height.
 - 3. All bolts, screws, nuts, and washers necessary to assemble the cover shall be included.
- E. Poles shall sustain a horizontal test load in accordance with manufacturer's specifications without failure of any component part.
- F. Luminaire arms for traffic signal poles shall sustain a vertical load of 100 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.
 - 1. The vertical deflection shall not exceed 5-1/2 percent of the bracket or mast arm length.
 - 2. The luminaire brackets or mast arms shall sustain a transverse horizontal load of 150 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.
 - 3. The horizontal deflection shall not exceed 10 percent of the bracket or mast arm length.
 - 4. The pole attached devices shall not develop any looseness within the specified loading range.
- G. Traffic signal mast arms shall sustain the vertical loads as represented in the Uniform Standard Drawings.
- H. All welds shall be continuous.
 - 1. One circumferential weld shall be allowed for each 10 feet of length and 1 longitudinal weld will be permitted in assembling the shaft.
 - 2. Where the sections are butt-welded together, the welded seams of adjacent sections shall be placed together to form a continuous weld.
 - 3. Butt joints shall be reinforced in the pole/arm by 3-inch wide sleeves of the same composition and gauge as the steel in the pole/arm.
 - 4. The sleeves shall be centered at the joint and shall be in full contact with the metals that are being joined.

5. The weld metal shall extend to the sleeve, making the sleeve an integral part of the joint.
6. Welding shall be done by American Welding Society (AWS) certified welders.
- I. All surplus weld material or protrusions shall be ground smooth.
 1. Ground joints shall maintain the strength of the original metal.
 2. Exposed welds, except fillet and longitudinal welds, shall be ground flush with the base metal.
- J. Exposed edges of base plates shall be broken. The pole shaft shall telescope through the base plate and shall be secured by 2 continuous welds, 1 on the inside at the bottom of the plate and the other on the outside on top of the plate.
- K. The pole shafts shall be of round cross section, with a minimum outer diameter at the base as shown in the Uniform Standard Drawings for the type of pole specified, and shall uniformly decrease in diameter at the rate of 0.14 inches per foot of length.
 1. The pole shafts may be multi-sided with a minimum roundness ratio of 98 percent so that the poles retain the appearance of a round unit.
 2. Multi-sided poles shall have a minimum of 16 sides.
 3. Poles that appear multi-sided, with noticeable edges between the sides that are clearly visible, may be rejected by the Engineer.
 4. Pole shafts shall be straight, with a permissive variation not to exceed 1/4 inch for each 10 feet of pole shaft.
 - a. A 30-foot pole would have 3/4 inch allowable deviation at the midpoint of the pole shaft.
 - b. A 20-foot shaft would have 1/2 inch allowable deviation.
 - c. A 10-foot shaft could deviate a maximum of 1/4 inch at the midpoint.
- L. Type 1-A and 1-B traffic signal poles shall be constructed of 0.120-inch or thicker steel with the dimensions shown in the Uniform Standard Drawings.
- M. A grounding lug shall be supplied interior to all signal and lighting pole shafts, including 1-A and 1-B pedestal poles, opposite the handhole for securing the grounding connections. This grounding lug shall be threaded to accept a standard 1/2-inch bolt and shall be welded to the inside of the pole where it is easily accessed for maintenance and repairs.
- N. Traffic signal pole luminaire mast arms shall be manufactured of tapered steel and shall be 15 feet.
 1. The tapered arms shall taper to provide a minimum of 7-1/2 inches of arm of a constant and uniform outside diameter of 2.4 inches perpendicular to the shaft for attaching the luminaire.
 2. Alternatively, the arm may include a luminaire end consisting of 2-inch, Schedule 40 pipe, conforming to ASTM A53 or ASTM A500, Grade B, welded in place so that a minimum of 7-1/2 inches is exposed for the attachment of the luminaire.
 3. The pole attachment end shall include a 3-bolt, rain-tight steel fitting as called for on Standard Drawing No. 318.
 4. The fitting shall be welded in place.

5. The bolts shall be high strength conforming to ASTM A325.
- O. Signal poles and arms shall be fabricated from weldable grade sheet steel having a minimum yield strength, after fabrication, of 48,000 psi.
- P. All 30- and 40-foot traffic signal poles shall be furnished with 2 luminaire mast arm mounting plates with the 3-bolt simplex shown in the Uniform Standard Drawings.
- Q. All surplus weld material or protrusions shall be ground smooth.
 1. Ground joints shall maintain the strength of the original metal.
 2. Exposed welds, except longitudinal and fillet welds, shall be ground flush with the base metal.
 3. Anchor bolts, nuts, and washers for traffic signal poles shall conform to the Uniform Standard Drawings for the type of pole specified and shall be hot-dip galvanized.
 4. The bolts shall be galvanized for the entire length of the bolt.
- R. Handholes in the base of XX, XX-A, and XX-B traffic signal poles shall have a minimum OD of 6 inches by 9 inches.
 1. Handholes shall face away from oncoming traffic and shall be located 12 inches above the base plate.
 2. The handhole shall be 6 inches by 9 inches OD reinforced frame with flat or indented type cover.
 3. The handhole cover shall utilize two 1/4-inch standard thread screws secured to steel plates welded inside the handhole opening to hold the cover in place.
 4. The screws shall be a weather and vandal resistant 1/4-inch hexagonal socket head screw.
 5. Handholes may be rectangular or oval.
- S. Handholes opposite the traffic signal mast arms of XX, XX-A, and XX-B traffic signal poles shall have a minimum OD of 6 inches by 9 inches.
 1. Handholes shall be 180 degrees opposite the signal mast arms and shall conform to the Uniform Standard Drawings.
 2. The handhole shall be centered with the mast arm assembly.
 3. The handhole cover shall utilize two 1/4-inch standard thread screws secured to steel plates welded inside the handhole opening to hold the cover in place.
 4. The screws shall be a weather and vandal resistant 1/4-inch hexagonal socket head screw.
 5. Handholes may be rectangular or oval.
- T. Handholes for 1-A and 1-B traffic signal poles shall have a minimum OD of 4 inches by 6 inches, and the bottom shall be 8 inches above the base plate.
 1. The cover plate shall be secured with two 1/4-inch bolts secured to steel plates welded inside the handhole opening with standard thread and tamper-proof hexagonal heads.
 2. Handholes may be rectangular or oval.

- U. Poles, arms, and associated hardware to be painted shall be galvanized in accordance with ASTM A123 and ASTM A153 prior to applying the finish coating.
 - 1. The finish of the galvanized materials shall then be prepared according to the paint manufacturer's recommendation before the finish paint or powder coating is applied.
 - 2. The finish coating shall consist of a minimum of 2 coats of aliphatic urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder.
 - 3. The finish shall be colored as specified in the Contract Documents or by the Engineer at the time of order.
- V. The manufacturer's identification tag shall be mounted above the handhole.

623 T.02.14 INTERCONNECT JUNCTION CABINET

- A. Traffic signal interconnect junction cabinets are not permitted except as specifically approved by the Engineer in consultation with FAST.
- B. The interconnect junction cabinets shall be Tesco Enclosure Class 22-000-NR, 43 inches by 20 inches by 11 inches, or approved equal.
- C. The cabinet shall be equipped with 1 Reliable Electric No. R66B4-25 terminal block, or approved equal, having capacity for 25 pairs of No. 22 AWG wire.
- D. The terminal block shall be mounted on a painted wood panel secured to the back of the cabinet.
- E. The Contractor shall provide and install a door lock with a key and all foundation, anchor bolts, and hardware in accordance with instructions of the cabinet manufacturer.

623 T.02.15 RED LIGHT DISPLAY INDICATORS

- A. Red light display indicators shall be installed at the locations shown in the Drawings or as directed by the Engineer.

623 T.02.16 INTERNALLY ILLUMINATED STREET NAME SIGNS

- A. Internally illuminated street name signs shall be provided at all traffic signal locations, unless otherwise specified in the Contract Documents.
- B. The signs shall be 8 feet long and 22-5/16 inches high with street names on both sides of the sign. The signs shall be weather-tight and consist of 6063 T-5 alloy aluminum housing.
- C. The sign panels shall be fabricated of clear plastic sheeting having a minimum thickness of 0.1875 inches with aluminum framing.
 - 1. The clear plastic panels shall be covered with translucent white, wide-angle, prismatic reflective sign face sheeting, and either reverse-screened with manufacturers' recommended green ink and clear coating or overlaid with green, electronic cuttable, transparent overlay film.
 - 2. The sign sheeting shall be applied in a vertical orientation in accordance with the manufacturer's recommendations.
 - 3. The sign face shall have a 2-1/4-inch white border.
 - 4. Sign lettering shall be 8-inch series D upper/lower case design unless otherwise specified by the Engineer.
 - 5. Lower case letters shall be 5 inches in height.

6. The sign face shall have the compass direction of the location marked in the upper left corner of each sign panel with a 5-inch upper case letter (N, S, E or W).
 7. The street name suffix (Street, Way, Blvd., and so forth) shall be displayed in the upper right corner of the sign panel with upper case letters.
 8. The street address number of the location shall be shown at the lower right corner in 5-inch upper case letters and numerals.
 9. Engineer approval is required for the sign faces prior to fabrication.
- D. The lighting ballast shall be Advance 120V, 60 Hz RSM175STP, Class P, Type HL, Type 1 outdoor ballast.
1. Lamps shall be 430 mA cool white.
 2. Two lamps, spaced 6 inches apart, are required for each lighted sign.
 3. A lighting ballast is required for each lamp.
- E. The internal wires shall be carefully installed along the side of the street name sign canister and shall be secured in place with a continuous bead of clear silicon rubber.
- F. The sign shall be capable of withstanding winds of 100 mph without damage.

623 T.02.17 ELECTRICAL SERVICE

- A. Electrical service pedestals to be installed for traffic signals systems shall comply with Subsection [623 G.02.07](#), "Electrical Service Pedestals."
- B. Connection to the electrical utility shall be as shown on the Drawings, as indicated in the Special Provisions, or as directed by the Engineer.
- C. The Contractor shall be responsible for coordinating with the electrical utility at the proper time to ensure the electrical connection will be energized on schedule.

623 T.02.18 UNINTERRUPTIBLE POWER SUPPLY SYSTEMS (UPS)

- A. When specified, an uninterruptible power supply system shall be supplied in accordance with the Contract Documents.

CONSTRUCTION**623 T.03.01 PAINTING**

- A. The preparation and finishing of new equipment and refinishing existing materials shall be as follows:
1. Galvanized and stainless steel devices shall not be painted unless otherwise specified in the Contract Documents or approved in writing by the Engineer.
 2. Non-ferrous surfaces shall be painted only if specified in the Contract Documents or approved and directed by the Engineer. Surfaces shall be cleaned and coated with vinyl wash primer. Ferrous metal surfaces shall be cleaned and immediately coated with the primer specified in Subsection [714.03.01.B](#), "Pre-Treatment, Vinyl Wash Primer (State Specification 8010-61J-27)."
 3. All traffic signal poles, posts, and mast arms shall be hot-dip galvanized by the manufacturer in accordance with ASTM A123. Traffic signal poles shall not be painted unless specifically called for in the Drawings and Special Provisions.

4. Directional louvers and backplates shall be painted flat black.
5. Traffic signal cabinets and controller boxes shall conform to Subsection [623 T.02.01](#), "Traffic Signal Controller Cabinets."
6. Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be refinished by the Contractor to the satisfaction of the Engineer.
7. Existing equipment and material to be repainted, whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt, and poorly bonded paint to the satisfaction of the Engineer.
8. All bare metal shall be prime painted immediately after cleaning, or as specified for new material. Two finish coats shall then be applied over newly primed areas.
9. Blast cleaning of galvanized metal surfaces that are in good condition will not be permitted.
10. Paint coats may be applied either by hand brushing or by approved spraying machines with the work performed in a neat and workmanlike manner.
 - a. No spraying shall be done at the job site in windy or bad weather conditions unless approved by the Engineer.
 - b. The Engineer may require the use of brushes or spray equipment for the application of paint depending on the application and the weather conditions.
11. The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any 1 coat of paint shall be corrected to the satisfaction of the Engineer before the next coat of paint is applied.
12. The final coat shall present a smooth surface, uniform in color, and free of runs, sags, excessive brush marks, tiger-striping, or other deformities as determined by the Engineer.
13. Galvanizing repair shall consist of metalizing or hot-stick galvanizing.
 - a. Surfaces regalvanized shall be prepared in accordance with ASTM A780.
 - b. Application of the zinc metalizing protection shall be in accordance with ANSI/AWS C2.18-93.
 - c. Zinc soldering or hot-stick galvanizing shall be performed by skilled personnel familiar with the procedure and surrounding areas shall not be damaged by the heat applied.
 - d. In either case, the renovated areas shall have a zinc coating thickness of at least as thick as that specified in ASTM A123.
 - e. Cold galvanizing spray or other methods of applying cold galvanizing shall not be allowed.

623 T.03.02 ELECTRICAL TESTING

- A. Prior to completion of the work, the Contractor shall cause the following tests to be made on any or all new electrical circuits, as required by the Engineer and in the presence of the Maintaining Agency representative:
 1. Test for continuity of each circuit.

2. A visual inspection of all grounding connections. Electrical equipment and components shall not be energized unless properly grounded as specified in the Contract Documents and directed by the Engineer.
3. A megohmmeter test on each single conductor circuit between the circuit conductor and all other circuits and ground as specified in the Contract Documents and directed by the Engineer.
 - a. The insulation resistance shall not be less than 500 megohms when tested at 500 volts.
 - b. Individual conductors in traffic signal cable, RF cable, Opticom cable, CCTV power cable, communications cable, other multi-conductor cables, and coaxial cables shall be exempted from the megohm testing by the Engineer if a visual inspection of these cables shows no suspicious cuts, tears, or other damage to the outside insulation.
 - c. Under no circumstances shall street light fixtures, video detection cameras, or other low voltage components be subjected to the high voltage of this test.
4. A flash test for traffic signal installations to verify the terminals and connections before turn-on.
5. A functional test in which it is demonstrated that all parts of the system function as specified or intended.
6. Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor immediately. All repairs and material replacements shall be completed to the satisfaction of the Engineer.

623 T.03.03 GROUNDING

- A. All electrically conductive materials of the electrical system shall be connected to earth and system grounds and shall conform to the following:
 1. Metal pull box covers shall be grounded with No. 4 AWG 7-strand copper wire connected to the system ground and the pull box cover.
 - a. The connection to the pull box cover shall be made using an exothermal welding system that is appropriate for the material of the cover.
 - b. An irreversible compression type connector shall be used to connect to the system grounding conductor.
 2. The Contractor shall be responsible for grounding the electrical system including pull boxes, poles, cabinets, conduits, service pedestals, and other enclosures to the satisfaction of the Engineer. No separate payment shall be made for this work unless specifically shown in the list of pay items.
 3. Poles and traffic signal cabinets shall be grounded to the system and earth grounds using bare No. 4 AWG copper wire connected to the anchor bolts of the concrete foundation and to the grounding plate installed under the foundation. Grounding the system shall comply with Standard Drawing 404.213.
 4. Service pedestals shall be grounded using UFER ground of 20 feet of No. 4 AWG, bare, stranded copper conductor coiled under the foundation of the pedestal.
 5. The bare grounding wire of traffic signal poles shall be equipped with a copper grounding lug to be attached to the equipment ground screw.

- a. The lug shall be sized to snugly fit over the grounding bolt of the equipment.
- b. The grounding wire lug shall be an irreversible, compression type component and shall be installed on the bare grounding conductor 24 inches from the end of the wire to allow connection of other grounding conductors to the end of the bare wire.
- c. The grounding lug shall be installed so that the bare grounding wire end, when pulled through the handhole, shall have a minimum length of 12 inches outside of the pole.
- d. The No. 8 AWG green system grounding conductor from the conduit and all other grounding conductors servicing equipment on the pole shall be connected to the end of the bare grounding conductor with a removable, mechanical device such as a split bolt.

623 T.03.04 CABINET INSTALLATIONS

- A. Electrical service pedestals and traffic signal controller cabinets shall not be installed in areas that are regularly irrigated with broadcast sprinklers or areas that may become flooded with sprinklers.

STREET LIGHTING SECTION

DESCRIPTION

623 L.01.01 GENERAL

- A. Street lighting construction shall consist of furnishing, installing, modifying, or removing street light poles and fixtures or other electrical installations in the roadway right-of-way as shown on the Drawings and specified in the Contract Documents.
- B. The locations of street light poles, electrical services, and other associated equipment shown on the Drawings are approximate. The Engineer will confirm exact locations of these items in the field.
- C. All materials furnished and installed shall be manufactured, handled, and used in a manner to ensure completed work with undamaged equipment and materials in accordance with the Drawings, specifications, and Special Provisions. Engineer approval of all materials shall be required prior to installation.
- D. All systems shall be complete and in satisfactory operating condition at the time of acceptance including successful completion of all testing required by these specifications.
- E. All work performed on any street lighting component or system shall be under the direct on-site supervision of an Electrician certified as a Journeyman or greater. An electrician with Journeyman level status certification or IMSA Roadway Lighting certification shall supervise the installation of electrical raceways that are part of a street lighting system.
- F. The Contractor shall be responsible for locating and protecting all underground and aerial utilities and infrastructure improvements.
 - 1. The exclusion of utilities and other structures on the Drawings or in the Special Provisions does not limit the Contractor's responsibility for these construction elements.
- G. If specified in the Contract Documents, GPS coordinates shall be supplied.

MATERIALS

623 L.02.01 STREET LIGHT POLES AND ARMS

- A. All lighting poles shall consist of a continuous tapered round steel pole shaft of the length specified, pole cap, anchor bolt cover, and hand hole cover(s), with the bolts, nuts, and washers necessary to complete the installation of the pole shaft.
- B. The luminaire arm shall have a minimum length of 8 feet.
 - 1. The arm shall be formed from 2-inch, Schedule 40 pipe, with standard 2.4-inch outside diameter (OD) conforming to ASTM A53 or ASTM A500, Grade B.
 - 2. The overall length and vertical rise of the arm shall be in a ratio of 1:4, vertical to horizontal.
 - 3. The overall shape of the curvature of the arm shall be similar to the arms shown on Standard Drawing 316.
 - 4. A minimum straight portion of 7-1/2 inches shall be provided to attach the luminaire.
 - 5. The pole shaft end of the arm shall have a single bolt, rain-tight, steel fitting with a cupped rim, simplex hooking mechanism.
 - 6. The fitting on the arm shall be shaped to lock over the street light pole simplex fitting by gravity and shall be secured by a single 1/2-inch bolt with standard thread.
- C. Luminaire mast arms 10 feet and longer shall be manufactured of tapered steel tubing.
 - 1. The arms shall taper to provide a minimum of 7-1/2 inches of arm of a constant and uniform outside diameter of 2.4 inches perpendicular to the shaft for attaching the luminaire.
 - 2. Or, alternatively, the arm may include a luminaire mounting end consisting of 2-inch, Schedule 40 pipe, conforming to ASTM A53, welded in place so that a minimum of 7-1/2 inches are exposed for the attachment of the luminaire.
 - 3. The pole attachment end shall include a 3-bolt, rain-tight, steel simplex fitting as called for on Standard Drawing No. 318.
 - 4. The fitting shall be welded in place.
 - 5. The bolts shall be high strength conforming to ASTM A325.
- D. Pole assemblies, luminaire mast arms and brackets, anchor-bolt and handhole covers, and pole and mast arm caps shall be hot-dip galvanized in conformance with ASTM A123.
 - 1. Associated hardware shall be hot-dip galvanized in accordance with ASTM A153.
 - 2. Flaws in the appearance of galvanized components shall be cause for rejection.
 - 3. The Engineer will reject galvanized materials with finishes that have a striped or uneven appearance, a buildup of zinc hydroxide, rust stains, ash inclusions, dross protrusions, and/or flux inclusions.
 - 4. Galvanized materials that exhibit a spidery, blotchy, or spotted appearance, that have a general surface roughness, or that exhibit lumpiness or runs in the finish shall also be rejected.
- E. Anchor-bolt covers shall be a 2-piece aluminum or ferrous metal design with a finish to match the pole shaft, shall cover the base plate completely, and shall be firmly secured in place at the bottom of the pole.

1. Anchor-bolt covers for street light poles shall rest on the top of the foundation when installed properly but shall not exceed 6 inches in height.
 2. All bolts, screws, nuts, and washers necessary to assemble the cover shall be included.
- F. Luminaire arms for street light poles shall sustain a vertical load of 100 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.
1. The vertical deflection shall not exceed 5-1/2 percent of the bracket or mast arm length.
 2. The luminaire brackets or mast arms shall sustain a transverse horizontal load of 150 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.
 3. The horizontal deflection shall not exceed 10 percent of the bracket or mast arm length.
 4. The pole attached devices shall not develop any looseness within the specified loading range.
- G. The pole shafts shall be of round cross section, with a minimum outer diameter at the base as shown in the Uniform Standard Drawings for the type of pole specified, and shall uniformly decrease in diameter at the rate of 0.14 inch per foot of length.
- H. Pole shafts shall be straight, with a permissive variation not to exceed 1/4 inch for each 10 feet of pole shaft.
1. A 30-foot pole would have 3/4 inch allowable deviation at the midpoint of the pole shaft.
 2. A 20-foot shaft would have 1/2 inch allowable deviation.
 3. A 10-foot shaft could deviate a maximum of 1/4 inch at the midpoint.
- I. Poles shall sustain a horizontal test load of 500 pounds applied 18 inches from the top of the shaft in any direction without failure of any component part, and with a deflection of not more than 7-1/2 percent of the pole shaft length as measured from point of load application to the base plate.
- J. All welds shall be continuous.
1. One circumferential weld shall be allowed for each 10 feet of length and 1 longitudinal weld will be permitted in assembling the shaft.
 2. Where the sections are butt-welded together, the welded seams of adjacent sections shall be placed together to form a continuous weld.
 3. Butt joints shall be reinforced in the pole/arm by 3-inch wide sleeves of the same composition and gauge as the steel in the pole/arm.
 4. The sleeves shall be centered at the joint and shall be in full contact with the metals that are being joined. The weld metal shall extend to the sleeve, making the sleeve an integral part of the joint.
 5. Welding shall be done by AWS certified welders.
- K. All surplus weld material or protrusions shall be ground smooth.
1. Ground joints shall maintain the strength of the original metal.

2. Exposed welds, except fillet welds, shall be ground flush with the base metal.
- L. Street light pole safety bases shall conform to Uniform Standard Drawings or as specified in the Contract Documents and approved by the Engineer.
- M. Sheet steel used in the manufacturing process of street light poles shall have a minimum yield of 48,000 psi, or which after forming or cold rolling shall develop a minimum of 48,000 psi.
 1. Poles shall have a minimum thickness of 0.119 inch for 11 gauge poles and 0.179 inch for No. 7 gauge poles.
 2. The shaft shall be formed from not more than 1 piece of sheet steel for each 10 feet of pole length.
- N. The pole base plate shall be 1 inch thick for No. 11 gauge standards and 1-1/8 inch thick for No. 7 gauge pole shafts.
 1. Both base plates shall be 11-1/2 inches square and shall conform to ASTM A27, Grade 65-35 cast steel; ASTM A36 steel plate; or ASTM A283, Grade D steel plate.
 2. The base plates shall be slotted to accommodate four 1-1/8-inch anchor bolts equally spaced at the corners for a 10-1/2-inch to 11-1/2-inch bolt circle diameter.
 3. The slots shall be 2-1/8 inches long OD.
 4. Exposed edges of base plates shall be finished smooth with the corners neatly rounded to a radius of approximately 1/8 inch.
 5. The pole shaft shall telescope through the base plate and shall be secured by 2 continuous welds, 1 on the inside at the bottom of the plate and the other on the outside on top of the plate.
- O. If specified in the Contract Documents, the handhole shall be 6 inches by 9 inches OD reinforced frame with slip-resistant indented type cover located 12 inches above the base plate.
 1. Otherwise, a 4-inch by 6-inch reinforced frame with slip-resistant type cover shall be supplied.
 2. The handhole cover shall utilize two 1/4-inch standard thread screws to secure the cover in place.
 3. The screws shall be a weather and vandal resistant 1/4-inch hexagonal socket head screw.
- P. A grounding lug shall be supplied interior to the pole shaft opposite the handhole for securing the grounding connections. This grounding lug shall be threaded to accept a standard 1/2-inch bolt and shall be welded to the inside of the pole where it is easily accessed for maintenance and repairs.
- Q. The manufacturer's identification tag shall be placed above the handhole.

623 L.02.02 ANCHOR BOLTS

- A. Anchor bolts for standard lighting poles shall conform to the following:
 1. Anchor bolts shall conform to ASTM F1554, Grade 55, or ATSM A307 and shall have a minimum yield strength of 36,000 psi.
 2. Anchor bolts shall be provided with 2 nuts and two 2-inch washers.

3. The anchor bolts and all nuts and washers shall be galvanized by the hot-dip process conforming to ASTM A123 and ASTM A153.
4. Anchor bolts shall be galvanized for the entire length of the bolt.
5. After galvanizing, the bolt threads shall accept the standard galvanized nuts for the full length of the thread without requiring tools, causing removal of protective coating, or requiring rethreading of the bolt or nut.
6. Anchor bolts for No. 7 gauge street light poles shall be 1-1/8 inches by 40 inches by 4 inches.
7. Anchor bolts for No. 11 gauge street light poles shall be 1 inch by 36 inches by 4 inches.
8. The upper 8 inches of the anchor bolts shall be threaded.

623 L.02.03 STREET LIGHTING LUMINAIRES

- A. The standard luminaire shall be of the high pressure sodium type, horizontal burning, cobra head style, and in wattages specified in the Contract Documents.
 1. The luminaire shall consist of a precision die cast aluminum housing, globe ring, lens, ballast, socket assembly, igniter, reflector, and hinged door.
 2. The hinged door shall be lowered by releasing a latch mechanism and allowing the door to swing free on its hinge.
 3. The latch assembly shall be easily operated while wearing lineman's gloves.
 4. The hinged door latch shall have an audible locking mechanism and shall provide easy access to the refractor, reflector, ballast, igniter, and lamp.
 5. The luminaire shall be provided with a terminal connection block installed in the upper housing.
- B. The luminaire fixture shall be bonded to earth ground with a grounding conductor.
- C. The luminaire housing and optical assemblies for 250-watt and 750-watt fixtures shall be the same size as is normally standard usage by the manufacturer for 400-watt fixtures.
 1. The slip fitter shall be capable of adapting to 1-1/4-inch through 2-inch pipe bracket without rearrangement of parts and be adjustable +5 degrees from horizontal.
 2. The optical assembly shall consist of an aluminum reflector, prismatic acrylic refractor for 100-watt luminaires, and borosilicate prismatic glass refractor for 150-watt through 750-watt luminaires or, when specified, shall be of polycarbonate resin vandal resistant material.
 - a. The refractors shall have accurately molded light controlling prisms and shall be resistant to impact and thermal shock.
 - b. The refractor shall provide maximum transmission and minimize unwanted spill light.
 - c. The socket size shall be mogul.
 - d. The socket shall be heavy duty, 20-ampere shrouded porcelain and shall be vertically and horizontally adjustable to obtain variations in light distribution patterns.
 - e. The socket shall have a non-cantilevered, spring loaded contact.

- f. Standard street light fixtures shall be supplied with medium semi-cutoff photometrics and IES type III distribution, unless otherwise specified in the Contract Documents or directed by the Engineer.
- D. The starting aid (igniter) for all luminaires shall be the plug-in type, removable without the use of tools.
- E. The ballast shall be located in the top portion of the light fixture and shall be prewired to the lamp socket and terminal board.
 - 1. Ballasts mounted on the hinged door are not allowed.
 - 2. The ballast shall be of a "multi-tap" configuration, capable of starting and operating the lamp of the type and wattage indicated in Drawings and specified herein from a nominal 120-volt, 240-volt, 60 Hz power source, as shown in the Drawings within the limits specified by the lamp manufacturer.
 - 3. The ballast, including starting aid, shall protect itself against normal lamp failure modes.
 - 4. The ballast shall be capable of operating the lamp in an open or short circuit-condition for 6 months without significant loss of ballast life.
- F. The ballast shall be a magnetic regulator type.
 - 1. The coils and insulation shall be impregnated and baked using a high temperature varnish.
 - 2. This treatment shall make the ballast impervious to normal moisture and environmental conditions and shall provide mechanical strength to thoroughly bond the coils to withstand vibration and shock.
- G. The ballast shall reliably start and operate the lamp in ambient temperatures down to -30 degrees F for the rated life of the lamp.
 - 1. Ballast primary current during starting shall not exceed normal operating current.
 - 2. The lamp current crest factor shall not exceed 1.8 for ± 10 percent line voltage variation at any lamp voltage.
 - 3. The power factor of the lamp-ballast system shall not drop below 0.95 for ± 10 percent line voltage variations at any lamp voltage.
 - 4. The ballast design shall be such that the normal manufacturing tolerance for capacitors of ± 6 percent will not cause more than a ± 5 percent variation in regulation throughout rated lamp life for nominal line voltage.
- H. Cut off luminaires shall be furnished for intersection lighting unless otherwise specified in the Contract Documents or directed by the Engineer.
 - 1. This luminaire shall meet all of the applicable specifications contained herein and provide true 90-degree light cutoff and shielding with an Alzak aluminum reflector, a heat and impact resistant flat (or sag) glass lens, a 2-position adjustable socket holder, and a mogul size porcelain screw shell socket with lamp grips.
 - 2. Maximum candela at 80 degrees shall be 9 and maximum candela at 90 degrees shall be 0.
 - 3. The light distribution shall be IES Type III.

4. Intersection lighting installed in conjunction with traffic signals or at future traffic signal locations shall be 120-volt, HPS with IES SC3 optics.
- I. Luminaires shall be leveled and adjusted in accordance with instructions of the manufacturer or as directed by the Engineer.
 1. A leveling mechanism shall be provided for leveling the luminaire in both major directions.
 2. A bubble leveling device shall be provided on the exterior of the luminaire to aid in this process.
- J. Capacitors shall be suitably protected from corrosion and isolated from higher temperatures created by the ballast.
- K. A slip-fitter shall be provided with a leveling clamp providing ± 5 degrees vertical leveling.
- L. All parts and fittings shall have a corrosion resistant finish.
 1. The housing shall be free of any casting or forming burrs before the finish is applied.
 2. Luminaires shall be painted with 2 finish coats of high gloss gray enamel or polyurethane powder coating.
- M. The complete unit shall have uniform lines throughout and shall aesthetically combine in a cobra head design. The luminaire shall maintain the horizontal line of the housing when properly mounted on the bracket arm.
- N. A permanent data sheet shall be provided on the inside of the housing containing pertinent information, such as a connection diagram, operating voltages, size of lamp required, part number of required igniter, and ballast requirements.
- O. Heat and moisture resistant silicon rubber or fiber gaskets shall be provided around the reflector to produce a completely sealed optical assembly. A heat resistant silicon gasket shall also be provided between the reflector and the socket.
- P. Unless otherwise specified in the Contract Documents or directed by the Engineer, all street lighting luminaires shall be furnished complete with high-pressure sodium high intensity discharge lamps with the following characteristics:

Type/Watts	Description	ANSI Code	Lamp	Initial Lumens	Rated Life
HPS 750	LU750	S51WA-400	Clear	110,000	16,000 hours
HPS 400	LU400	S51WA-400	Clear	50,000	24,000 hours
HPS 250	LU250	S50VA-250	Clear	28,000	24,000 hours
HPS 200	LU200	S66MN-200	Clear	22,000	24,000 hours
HPS 150	LU150/55	S55SC-150	Clear	16,000	24,000 hours
HPS 100	LU100	S54SB-100	Clear	9,500	24,000 hours

- Q. The Contractor shall guarantee that all lamps that fail within 1 year under normal operating conditions shall be replaced at no additional cost to the Contracting Agency.
- R. All luminaires and component parts shall be new with labels in accordance with ANSI standards. Reconditioned, reconstructed, or remanufactured luminaires and component parts are not acceptable.
- S. Engineer approval of all street light fixtures shall be required prior to installation.

623 L.02.04 FUSEHOLDERS AND FUSES

- A. This subsection applies to multiple street lighting circuits only.
- B. Fuseholders and fuses shall be installed in the bases of all street lighting poles and shall be accessible through the handholes.
 - 1. The fuseholders shall be single pole for 120 volts or double-pole for 240 volts.
 - 2. The fuseholders shall be waterproof without the use of tape, with integral or separate conductor insulating boots.
- C. The single pole fuse holders used for 120-volt circuits shall be composed of 2 parts that consist of sections for the line side and the load side. The fuseholder body and terminals shall be vapor and waterproof when the line and load sections are mated together according to the manufacturer's recommendations.
- D. The double-pole fuseholder shall contain 2 fuseholder chambers that consist of a line side section and a load side section that are secured together with a screw when properly closed. Both load side connections shall be simultaneously disconnected when the fuseholder is opened.
- E. Electrical arcs that may occur when connecting the matching pieces while the circuit is operational shall be confined within the body when a properly sized fuse is seated firmly in the terminals.
- F. Fuse holders shall be rated for 600 volts and shall accept Midget 250-volt L4J12F fuse or approved equal. Glass, paper, or indicating type fuses are not acceptable.

623 L.02.05 STREET LIGHTING SYSTEMS

- A. Unless otherwise specified on the Drawings, all the street lighting systems shall be 240-volt, single phase, 2-wire circuits connected in parallel (multiple).
- B. Unless otherwise specified in the Contract Documents or approved by the Engineer, the 2-wire system shall consist of two No. 4 AWG stranded copper conductors with black and red THW-2 or XHHW-2 insulation to carry the load, and 1 green 8 AWG THW-2 or XHHW-2 equipment bonding conductor. Engineer approval of conductors to be installed shall be required prior to installation.
- C. The service wire for the 240-volt/100-amp pole mounted service panel shall be three No. 1/0 AWG, stranded copper, THW-2 or XHHW-2 conductors from the service panel to the electrical utility transformer.
- D. Electrical services installed for lighting on collector or arterial streets shall be standard electrical service pedestals and shall comply with Subsection [623 G.02.07](#), "Electrical Service Pedestals."
- E. Unless otherwise specified in the Contract Documents, the cable from the base of the lighting pole to the luminaire shall be 3 conductors (one of them ground), No. 10 AWG solid copper with insulation, rated at 600 volts. The individual conductors shall be insulated with TW grade, and the outer jacket shall be PVC jacket type UF grade.

MISCELLANEOUS ELECTRICAL EQUIPMENT**623 L.02.06 STREET LIGHT CONTROLS**

- A. Contactor shall be a heavy-duty, commercial, mechanical armature type.

1. The mechanical type shall consist of an operating coil, a laminated core, a laminated armature, contacts, and terminals.
2. Contacts shall be silver alloy.
- B. For series lighting systems the photoelectric control shall be capable of switching series lighting systems through a high voltage controller.
- C. Types of photoelectric controls shall be as follows:
 1. Type I. Type I photoelectric control shall consist of a photoelectric unit and a contactor in a single weatherproof housing.
 2. Type II.
 - a. Type II photoelectric control shall consist of a photoelectric unit installed at the top of the first lighting standard from the service point, and shall control the lighting contactor in the pad mounted service cabinet.
 - b. A bypass switch shall be included to permit manual operation of the lighting system contactor.
 - c. Unless otherwise specified in the Contract Documents, the photoelectric units shall be for 120-volt operation on 2-wire or 3-wire single phase multiple lighting systems.
 3. Equipment Details.
 - a. The photoelectric unit shall consist of a light sensitive element connected to a control relay.
 - b. The light sensitive element shall have a spectral response such that it is especially sensitive to north sky illumination and shall have an ON level adjustable between minimum limits of 0.6 footcandles and 1.1 footcandles.
 - c. The unit shall be so designed that a failure of any electrical or electronic component will energize the lighting circuit.
 - d. The photoelectric unit shall be mounted at the top of the standard designated on the Drawings and shall be oriented as directed by the Engineer.
 4. Contactor.
 - a. The contactor shall be constructed in accordance with NEMA standards for lighting contactors and shall have contacts rated to switch the specified lighting load.
 - b. Contactor shall be the mechanical armature type.
 - c. The mechanical type shall consist of an operating coil, a laminated core, a laminated armature, contacts, and terminals.
 - d. Contacts shall be silver alloy.
 5. Housing.
 - a. The contactor may be either integral with the photoelectric unit or may be located externally from it.
 - b. When located externally, the contactor shall be housed in a suitable NEMA Type 3 rain-tight enclosure with hasp for a padlock.

- c. The rain-tight enclosure shall be mounted on the same standard as the photoelectric unit at a height of approximately 28 feet above the base.
- d. All contactors' housings shall be approved by the Engineer prior to installation.
- 6. Wiring. Conductors between the photoelectric unit and an external contactor shall be a minimum No. 12 AWG, and shall be installed inside the lighting standard.

623 L.02.07 PAINT

- A. Unless otherwise specified herein all metal parts, fittings, signal heads, posts, pedestals, standards, cabinets, controller boxes, and so forth shall be prepared and painted according to these specifications.
- B. Types of paints to be used shall be as specified in Section [714](#), "Paint and Pavement Markings."

CONSTRUCTION**623 L.03.01 PAINTING AND FINISH REPAIR**

- A. The preparation and refinishing of existing equipment to be reused on projects shall be as specified below.
- B. Galvanized, ferrous, and nonferrous surfaces to be painted shall be cleaned and immediately coated with vinyl wash primer, conforming to Subsection [714.03.01.B](#), "Pre-Treatment, Vinyl Wash Primer (State Specification 8010-6J-27)."
- C. Primer coats applied by the manufacturer shall be checked by the Engineer and shall be repainted by the Contractor if necessary. Primer coats that are considered to be in good condition by the Engineer shall not require reapplication by the Contractor.
- D. All removed and reused equipment and equipment that has been repaired in-place shall require appropriate refinishing by the Contractor.
- E. Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer.
- F. Existing equipment and material to be repainted, whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt, and poorly bonded paint by any method satisfactory to the Engineer.
 - 1. Immediately after cleaning, all material shall be primed as appropriate and 2 finish coats of paint shall be applied after the primer coat has dried.
 - 2. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.
- G. Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators.
 - 1. No spraying shall be done at the job site in windy or bad weather conditions and unless approved by the Engineer.
 - 2. The work shall be done in a neat and workmanlike manner.
 - 3. The Engineer may require the use of brushes or spray equipment for the application of paint depending on the materials and the weather conditions.

- H. The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any 1 coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.
- I. The final coat shall present a smooth surface, uniform in color, and free of runs, sags, or excessive brush marks.
- J. Galvanizing repair of street light poles and appurtenances shall consist of metalizing or hot-stick galvanizing.
 - 1. Surfaces regalvanized shall be prepared in accordance with ASTM A780.
 - 2. Application of the zinc metalizing protection shall be in accordance with ANSI/AWS C2.18-93.
 - 3. Zinc soldering or hot-stick galvanizing shall be performed by skilled personnel familiar with the procedure, and surrounding areas shall not be damaged by the heat applied.
 - 4. In either case, the renovated areas shall have a zinc coating thickness of at least as thick as that specified in ASTM A123.
 - 5. Cold galvanizing spray or other methods of applying cold galvanizing shall not be allowed.

623 L.03.02 BONDING AND GROUNDING

- A. Metallic cable sheaths, steel conduit, metal poles, pedestals, pull boxes, and other metal enclosures shall be metallically joined together and made mechanically and electrically secure to form a continuous electrical conducting path, and shall be effectively grounded as required by the *National Electrical Code*.
- B. All conduits shall contain a No. 8 AWG, stranded copper grounding conductor with THW-2 or XHHW-2 green insulation to be used as a systems ground.
- C. Bonding of street light poles and foundations shall be accomplished with a bare No. 4 AWG stranded copper wire attached to each anchor bolt and to the grounding bolt installed on the lower lip of the lighting pole handhole or inside the base of the pole as shown on the Uniform Standard Drawings.
 - 1. The grounding end of the bare wire shall be connected to a grounding plate installed under a felt protective insulator under the foundation.
 - 2. An extra length of 20 feet of No. 4 AWG grounding wire shall be coiled under the foundation for added contact with the earth.
 - 3. The No. 8 AWG green systems grounding conductor from the conduit and the No. 10 AWG luminaire ground shall be connected to the No. 4 AWG bare foundation grounding wire.
- D. Additionally, all electrically conductive materials of the electrical system shall be connected to earth and system grounds and shall conform to the following:
 - 1. Pull box covers shall be grounded with No. 4 AWG 7-strand copper bare wire connected to the system ground and the pull box cover.
 - a. The connection to the pull box cover shall be made using an exothermal welding system that is appropriate for the material of the cover.

- b. An irreversible compression type connector shall be used to connect to the system grounding conductor.
2. The Contractor shall be responsible for grounding the electrical system in accordance with the Contract Documents including pull boxes, poles, cabinets, conduits, service pedestals, and other enclosures to the satisfaction of the Engineer.
3. Grounding of conduit and neutral at the service point shall comply with the applicable sections of Article 250 of the *National Electrical Code*.
4. Pole foundation grounding wire shall be equipped with a copper grounding lug to be attached to the equipment ground screw.
 - a. The lug shall be sized to fit over the 1/2-inch grounding bolt of the pole.
 - b. The grounding wire lug shall be an irreversible, compression type component and shall be installed on the bare grounding conductor approximately 24 inches from the end of the wire to allow connection of other grounding conductors.
 - c. The grounding lug shall be installed so that the bare grounding wire end, when pulled through the handhole, shall have a minimum length of 12 inches outside of the pole.
 - d. The No. 8 AWG green system grounding conductor from the conduit and all other grounding conductors servicing equipment on the pole shall be connected to the end of the bare grounding conductor with a removable, mechanical device such as a split bolt.

623 L.03.03 ELECTRICAL TESTING

- A. Prior to completion of the work, the Contractor shall cause the following tests to be made on all lighting and electrical circuits, as directed by the Engineer and in the presence of the Maintaining Agency representative:
 1. Test for continuity of each circuit.
 2. A visual inspection of all grounding connections. Electrical equipment and components shall not be energized unless properly grounded to the satisfaction of Engineer.
 3. A megohmmeter test on each single conductor circuit between the circuit conductor and all other circuits and ground in the conduits.
 - a. The insulation resistance shall not be less than 500 megohms when tested at 1,000 volts for 1 minute.
 - b. Individual conductors in UF cable and other multi-conductor cables shall be exempted from the megohmmeter testing by the Engineer if a visual inspection of the cables show no suspicious cuts, tears, or other damage to the outside insulation.
 - c. Under no circumstances shall street light fixtures or other low voltage components be subjected to the high voltage of this test.
 4. Any fault in any material or in a part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until corrected.

METHOD OF MEASUREMENT

623.04.01 MEASUREMENT

- A. The unit of measurement for "Traffic Signal Systems," "Street Lighting Systems," "Traffic Signal and Street Lighting Systems," and appurtenances for a complete operating system will be lump sum or unit price as specified in the Contract Documents.
- B. All measurements will be made in accordance with Subsection [109.01](#), "Measurement of Quantities."

BASIS OF PAYMENT

623.05.01 PAYMENT

- A. The lump sum price or unit prices paid for traffic signal systems, street lighting systems, sign illumination systems, service pedestals, modifying existing systems, or any combination thereof shall be full compensation for doing all the work complete and in place as indicated in the Contract Documents and as directed by the Engineer, including excavation and backfill; concrete foundations; restoring sidewalk, pavement, and appurtenances damaged or destroyed during construction; salvaging existing materials; and making all required tests.
- B. Full compensation for all additional materials and labor, not shown on the Drawings or specified, which are necessary to complete the installations of the various systems, shall be considered as included in the prices paid for the systems, or units thereof, and no additional compensation will be allowed therefor.
- C. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."

PAY ITEM**PAY UNIT**

Traffic Signal Systems (may include sign lighting)	Lump Sum or Unit Price
Street Lighting Systems (may include sign lighting)	Lump Sum or Unit Price

SECTION 104**SCOPE OF THE WORK****104.01 INTENT OF THE CONTRACT**

- A. The intent of the contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, material, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

104.02 INCREASED OR DECREASED QUANTITIES AND CHANGE IN CHARACTER OF WORK

- A. The Contracting Agency reserves the right to make by written order and without notice to surety, such alterations in the plans and specifications or character or quantity of the work which may be considered necessary or desirable from time to time during the progress of the work to complete satisfactorily the proposed construction. Such alterations shall not be considered as a waiver of any conditions of the contract or invalidate any of the provisions thereof.
- B. Whenever an alteration in character of work on the project involves a substantial change in the nature of the design or in the type or extent of construction which materially increases or decreases the cost of the performance, the work shall be performed in accordance with the plans and specifications and as directed, provided however, that before such work is started, a supplemental agreement acceptable to both parties to the contract shall be executed.
- C. The right is reserved to increase or decrease any or all of the items in the estimate of approximate quantities as shown in the proposal. The length of the project may be increased or decreased by adding or omitting sections or by relocation. Under no circumstances shall alterations of plans or of the nature of the work, involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.
- D. If it is found that the quantity of any major item required to complete the work underruns or overruns less than 25 percent of the proposed quantity, payment for the work performed will be made at the contract unit price for the quantity of work actually performed.
- E. Whenever the termini of the project are changed or whenever any change or combination of changes results in increasing or decreasing the original contract amount as calculated from the bid quantities and contract unit prices by more than 25 percent, a supplemental agreement acceptable to both parties to the contract shall be executed in advance of performing the affected work.
- F. Whenever an overrun or underrun of more than 25 percent of the original bid quantity for one or more major contract items occurs, either party to the contract may demand a supplemental agreement to be negotiated satisfactory to both parties.
- G. Revision of any unit price requested by the Contractor shall be negotiated on the basis of actual cost plus a reasonable allowance for profit and overhead. Written request for supplemental agreement shall set forth in detail the particulars and character by which the work was changed and by what amount the unit price of the proposal item will be altered. Failure of the Contractor to file a request for a supplemental agreement within 10 calendar days after any of the above outlined conditions are encountered shall be considered as a

waiver thereof on the part of the Contractor and payment shall be made at the contract unit price for the actual quantity of work performed.

- H. If a supplemental agreement satisfactory to both parties cannot be agreed upon, the Contracting Agency may order the work in dispute to be performed and the controversy shall be settled as provided in Subsection [105.17](#), "Claims for Adjustment and Disputes."
- I. Changes not requiring negotiated agreements, except as to extra work involved, shall be ordered by means of a contract change order, and acceptance by the Contractor, as evidenced by Contractor's signature, shall constitute agreement that the change does not involve any adjustment of contract unit prices. Attention is directed to Subsection [108.08](#), "Determination and Extension of Contract Time." Work shall not be started on any such change until the change order has been delivered to and accepted by the Contractor.
- J. In case the Contractor refuses to accept a change order, the Contracting Agency may order the work to proceed while proceeding as expeditiously as possible with settlement of the disputed points.

104.03 EXTRA WORK

- A. The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable in order to complete fully the work as contemplated. Such work shall be performed in accordance with the specifications and as directed, and will be paid for as agreed unit prices, force account, or a combination of the two. Agreed unit prices together with the estimated quantities of each unit shall be shown. Orders involving extra and force account work shall be as detailed in Subsection [109.03](#), "Extra and Force Account Work," and conform to the requirements contained therein.

104.04 MAINTENANCE OF TRAFFIC

- A. While undergoing improvements, all roads upon or within which any work is being done shall be kept open to all traffic by the Contractor unless otherwise provided for in the contract documents. If the useable roadway is not sufficient to safely accommodate two-way traffic, the Contractor shall adequately maintain one-way traffic. Wherever one-way traffic is in effect, the distance shall be as set forth in writing by the Engineer.
- B. Where controlled traffic is necessary for protection of the work or for the safety of public travel, it shall be in accordance with the provisions of Subsection [624.03.02](#), "Flaggers," and [624.03.03](#), "Pilot Cars," of these specifications. The Contractor shall also provide and maintain in a safe condition, temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms. The Contractor shall bear all expense of maintaining all roads upon or within which any work is being done and of constructing and maintaining such approaches, crossings, intersections, and other features as may be necessary, without direct compensation, except as provided in Subsection [107.15](#), "Relief from Maintenance and Responsibility," or in 1. below:
 - 1. The Contractor shall be responsible for the maintenance of the roadway during suspension of the work when such suspension is due to the Contractor's negligence. Attention is directed to Subsection [108.06](#), "Temporary Suspension of Work." During any other suspension, the Contractor shall make passable and shall open to traffic such portions of the project and temporary roadways or portions thereof as may be ordered by the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon will be by and at the expense of the

Contracting Agency. Contractor's maintenance and responsibility will include and be restricted to: the traveled roadway for the convenience of public travel; opening plugged pipes and roadway ditches and drains or correcting any other hazard which may be detrimental to adjacent property owners or the traveling public. When work is resumed, it shall be the Contractor's responsibility to replace, renew, and repair any work or materials lost or damaged because of such temporary use of the project regardless of the cause of such damage or loss, except as provided in Subsection [107.15](#), "Relief from Maintenance and Responsibility." It is herewith expressed that the Contracting Agency is in no way responsible to the Contractor to maintain the roadway and appurtenances in any certain condition or state of repair. It is incumbent upon the Contractor to complete the project in every respect as though its prosecution had been continuous and without interference.

- C. Where construction of a project is staged in the plans, or otherwise outlined by the contract documents, and if a change in the staging or sequence of operations is desirable, the Contractor may submit such change in writing to the Contracting Agency. Consideration will be given to each such proposal and may be rejected, modified, or accepted as is deemed best by the Contracting Agency. The Contractor will not proceed with any such change in the staging until permission is granted by the Contracting Agency in writing.
- D. When detours, temporary connections, crossovers, connection roads, and frontage roads are constructed by the item "Equipment Hours," such items shall be full compensation for excavating, hauling, overhaul, and compacting of the material complete and in place and for all labor involved to complete the detour. Base and surface courses will be paid for at the contract unit price for the particular type of material required. All of the above mentioned roadways will be constructed to the same standards and qualities and subject to the same tests and specifications as the main roadway, unless otherwise ordered by the Engineer. Attention is directed to Section [624](#), "Accommodations for Public Traffic."
- E. When a detour is requested by the Contractor, the Contractor shall make a written request to the Engineer for the establishment of a detour around all or certain designated sections of work. If arrangements for such a detour can be made which are satisfactory to the Contracting Agency, and to the Contractor, the Engineer will designate that road as a detour, subject to the following conditions:
 - 1. The Contractor shall provide and maintain the necessary route marking signs.
 - 2. The Contractor shall construct and maintain in good condition such a detour. If the Contractor fails to maintain the detour in a condition satisfactory to the Engineer, the Contracting Agency will make such repairs as is deemed suitable and will deduct the cost thereof from money due or to become due to the Contractor.
 - 3. Provisions for handling traffic will be subject to the conditions of Subsection [624.03.02](#), "Flaggers," and [624.03.03](#), "Pilot Cars."
 - 4. Upon abandoning the detour, the Contractor shall obliterate and dispose of such detour and restore as nearly as possible the condition of the ground to its original form to the satisfaction of the Engineer.
 - 5. All of the above work will be at the sole expense of the Contractor.

104.05 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK

- A. The Contractor with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material determined suitable by the Engineer, as may be found in

the excavation and will be paid for both the excavation of such materials at the corresponding contract unit price and also at the contract unit price for the pay item for which the excavated material is used. At no additional cost to the Contracting Agency, the Contractor shall replace with other acceptable material all of that portion of the excavation material so removed and used which was needed for use in the embankments, backfills, approaches, or otherwise. No charge for the materials so used will be made against the Contractor. The Contractor shall not excavate or remove any material from within the project location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

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

SECTION 105

CONTROL OF THE WORK

105.01 AUTHORITY OF THE ENGINEER

- A. The Engineer will decide all questions that may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; and all questions that may arise as to the interpretation of the plans and specifications.
- B. The Engineer will have the authority to suspend the work wholly or in part due to the failure of the Contractor to correct conditions unsafe for the workmen or the general public; for failure to comply with the technical provisions of the contract; for failure to carry out orders; for such periods as the Engineer may deem necessary due to unsuitable weather; and for conditions considered unsuitable for the prosecution of the work.
- C. Whenever the Contractor fails to carry out orders of the Engineer, the Engineer will have executive authority to enforce such orders and the Engineer's decision shall be final. In the event the Contractor fails to execute work ordered by the Engineer within a reasonable period of time, the Engineer may, after giving notice in writing to the Contractor, proceed to have such work performed as deemed necessary and the cost thereof shall be deducted from compensation due or which may become due the Contractor on the contract.
- D. Decisions of the Engineer shall be subject to appeal to the Board, whose decisions shall be final and conclusive. Such appeal shall be in writing and shall be made within 10 calendar days, but in the meantime the Contractor shall diligently proceed with the work.

105.02 PLANS AND WORKING DRAWINGS

- A. The contract plans and drawings do not purport to show all the details of the work. These documents are intended to illustrate the character and extent of the performance desired under the contract; therefore, they may be supplemented or revised from time to time, as the work progresses, by the Engineer or (subject to approval of the Engineer) by the Contractor. The Contractor will keep one set of plans available on the work at all times.
- B. The plans may be supplemented by such working drawings as are necessary to adequately control the work. Working drawings for structures shall be furnished by the Contractor. Working Drawings shall include stress sheets, shop drawings, erection plans, fabrication sheets, falsework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data required by the Engineer. Unless otherwise specified, all working drawings shall be submitted in triplicate 10 days prior to start of related work and approved by the Engineer. Such approval shall not relieve the Contractor of any of the Contractor's responsibility under the contract for the successful completion of the work. It is mutually agreed that the Contractor shall be responsible for agreement of dimensions and details as well as for conformity of the Contractor's working drawings with the approved plans and specifications.
- C. The contract price will include the cost of furnishing all working drawings.

105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS

- A. Work performed and materials furnished shall be in conformity with the lines, grades, cross sections, dimensions, and materials requirements, including tolerances, shown on the plans or indicated in the specifications.

- B. In the event the Engineer finds the materials or the finished product in which the materials are used not in conformity with the plans and specifications, but that acceptable work has been produced, the Engineer shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification concurred in by the Contracting Agency which will provide for an appropriate adjustment in the contract price for such work or materials as the Engineer deems necessary to conform to the Engineer's determination based on engineering judgment.
- C. In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by the Contractor at no additional cost to the Contracting Agency.

105.04 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, AND SPECIAL PROVISIONS

- A. The specifications, supplemental specifications, plans, special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. These documents are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, the following precedence will govern:
 - 1. Permits from other agencies as may be required by law.
 - 2. Special Provisions.
 - 3. Plans.
 - 4. Uniform Standard Drawings.
 - 5. Uniform Standard Specifications.
 - 6. Reference Specifications.
- B. Change orders, supplemental agreements, and approved revisions to plans and specifications will take precedence over Items 2, 3, 4, 5, and 6 listed above. Detailed plans shall have precedence over general plans.
- C. The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, the Contractor shall immediately notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

105.05 COOPERATION BY CONTRACTOR

- A. The Contractor will be supplied with a minimum of 4 sets of approved plans and contract assemblies including special provisions, one set of which the Contractor shall keep available on the work at all times. Additional copies of plans and special provisions may be obtained by the Contractor upon written request to the Contracting Agency.
- B. The Contractor shall give the work constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, the Engineer's inspectors, and other contractors in every way possible.

- C. The Contractor shall maintain a telephone for the duration of the contract, at no additional cost to the Contracting Agency, where the Contractor or the Contractor's authorized representative may be reached directly or by message at all times.
- D. The prime Contractor shall have on the work at all times, as the Contractor's agent, a competent superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or the Engineer's authorized representatives. Such superintendent shall be designated in writing before starting work. The superintendent shall have full authority to execute orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor, and incidentals as may be required. Such superintendent shall be furnished irrespective of the amount of work sublet.
- E. Whenever the Contractor or the Contractor's authorized representative is not present on any particular part of the work where it may be desired to give direction, orders will be given by the Engineer to the Contractor's superintendent, foreman, or other person in charge of the operation, who is present, and these orders shall have the same force and effect as if given to the Contractor or the Contractor's designated representative.
- F. Any order given by the Engineer, not otherwise required by the specifications to be in writing, will on request of the Contractor be given or confirmed by the Engineer in writing.

105.06 COOPERATION WITH UTILITIES

- A. The Permittee, in the case of private contract, and the Contracting Agency, in the case of cash contract or Special Improvement District contract, will search known substructure records which describe the location of utility substructures, and will indicate on the plans for the project those substructures, except for service connections, which may affect the work. Information regarding removal, relocation, abandonment, or installation of new utilities will be furnished to prospective bidders.
- B. Where underground main distribution conduits such as water, gas, sewer, electric power, telephone, or cable television are shown on the plans, the Contractor, for the purpose of preparing the Contractor's bid, shall assume that every property parcel will be served by a service connection for each type of utility.
- C. At least 2 working days before entering on the work, the Contractor shall notify all the utility owners to mark or otherwise indicate the approximate location of their subsurface facilities including, but not limited to, structures, main conduits, and service connections. This requirement will not apply to sewer and storm drain installations where their location and depth are shown on the plans for the project.
- D. It shall be the Contractor's responsibility to determine the location and depth of all utilities, including service connections, for which approximate locations have been marked by the respective owners and which the Contractor believes may affect or be affected by the Contractor's operations. If no pay item is provided in the contract for this work, full compensation for such work shall be considered as included in the prices bid for other items of work.
- E. The Contractor shall not interrupt the service function or disturb the supporting base of any utility without authority from the owner or an order from the Contracting Agency.
- F. Where protection is required to ensure support of utilities, the Contractor shall, unless otherwise provided, furnish and place the necessary protection at no additional cost to the Contracting Agency.

- G. Upon learning of the existence and location of any utility omitted from or shown incorrectly on the plans, or not properly marked, the Contractor shall immediately notify the Engineer in writing. When authorized by the Engineer, support or protection of the utility will be paid for as provided in Subsection [104.03](#), "Extra Work."
- H. The Contractor shall immediately notify the Engineer and the utility owner if the Contractor disturbs or damages any utility. The Contractor shall bear the costs of repair or replacement of any utility damaged if properly located as provided.
- I. When placing concrete around or contiguous to any utility installation, the Contractor, at no additional cost to the Contracting Agency, shall (1) furnish and install a 2-inch cushion of expansion joint material or other similar resilient material; or (2) provide a sleeve or other opening which will result in a 2-inch minimum clear annular space between the concrete and the utility; or (3) provide other acceptable means to prevent embedment in or bonding to the concrete. The standards of the affected utility company shall prevail. Where concrete is used for backfill or for structures which would result in embedment, or partial embedment, of a metallic utility installation, or where the coating, bedding, or other cathodic protection system is exposed or damaged by the Contractor's operations, or as may be required by the work, the Contractor shall notify the Engineer and arrange to secure the advice of the affected utility owner regarding the procedures required to maintain or restore the integrity of the system.
- J. Unless otherwise specified, the Contractor shall remove all interfering portions of utilities shown on the plans or indicated in the bid documents as "abandoned" or "to be abandoned in place." Before starting removal operations, the Contractor shall ascertain from the Contracting Agency whether the abandonment is complete, and the costs involved in the removal and disposal shall be absorbed in the bid for the items of work necessitating such removals.
- K. When feasible, the owners responsible for utilities within the area affected by the work shall complete their necessary installations, relocations, repairs or replacements before commencement of work by the Contractor. When the Special Provisions or plans indicate that a utility installation is to be relocated, altered, or constructed by others, the Contracting Agency will conduct all negotiations with the owners and the work will be done at no cost to the Contractor, except as provided in Subsection [107.17](#), "Contractor's Responsibility for Utility Property and Service." Utilities that are relocated in order to avoid interference with the proposed permanent work shall be protected in their relocated position and the cost of such protection shall be absorbed in the various items of the contract.
- L. A utility company installing a new line is responsible for relocation of other utility company facilities if the new line conflicts with existing locations.
- M. When the plans or specifications provide for the Contractor to alter, relocate, or reconstruct a utility, all costs for such work shall be included in the bid for the items of work necessitating such work. Temporary or permanent relocation or alteration of utilities requested by the Contractor for the Contractor's own convenience shall be the Contractor's responsibility, and the Contractor shall make all arrangements and bear all costs.
- N. The utility owner will relocate service connections as necessary within the limits of the work or within temporary construction or slope easement unless otherwise specified. When directed by the Engineer, the Contractor shall arrange for the relocation of service connections as necessary between the meter and property line, or between a meter and the limits of temporary construction or slope easements. The relocation of such service connections will be paid for in accordance with provisions of Subsection [104.03](#), "Extra

Work." Payment will include the restoration of all existing improvements which may be affected thereby. The Contractor may, for the Contractor's own convenience or to expedite the work, agree with the owner of any utility to disconnect and reconnect interfering service connections. The Contracting Agency will not be involved in any such agreement.

- O. The Contractor shall notify the Contracting Agency of the Contractor's construction schedule insofar as it affects the protection, removal, or relocation of utilities. This notification shall be in writing and shall be included as a part of the construction schedule required by Subsection [108.03](#), "Prosecution and Progress." The Contractor shall notify the Contracting Agency in writing of any subsequent changes in the Contractor's construction schedule which will affect the time available for protection, removal, or relocation of utilities.
- P. The Contractor will not be entitled to damages or additional payment for delays attributable to utility relocations or alterations if correctly located, noted, and completed. The Contractor may be given an extension of time for unforeseen delays attributable to utility relocations or alterations not shown or incorrectly shown on the plans, or for unreasonably protracted interference by utilities in performing work correctly shown on the plans. If the Contractor sustains loss due to delays attributable to interferences, relocations, or alterations which could not have been avoided by the judicious handling of forces, equipment, or plant, there shall be paid to the Contractor such amount as the Contracting Agency may find to be fair and reasonable compensation for such part of the Contractor's actual loss as was unavoidable as provided in Subsection [108.12](#), "Right-of-Way Delays."
- Q. When necessary, the Contractor shall so conduct the Contractor's operations as to permit access to the work site and provide time for utility work to be accomplished during the progress of the contract work.

105.07 COOPERATION BETWEEN CONTRACTORS

- A. The Contracting Agency reserves the right at any time to contract and perform other or additional work on or near the work covered by the contract.
- B. When separate contracts are let within the limits of any one project, each Contractor shall conduct Contractor's work so as not to interfere with or hinder the progress or completion of the work being performed by the other Contractors. Contractors working on the same project shall cooperate with each other as directed.
- C. Each Contractor involved shall assume all liability, financial or otherwise, in connection with Contractor's contract and shall protect and save harmless the Contracting Agency from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by Contractor because of the presence and operations of other Contractors working within the limits of the same project.
- D. The Contractor shall arrange Contractor's work and shall place and dispose of the materials being used so as not to interfere with the operations of other Contractors within the limits of the same project. Contractor shall join Contractor's work with that of the others in an acceptable manner and shall perform the work in proper sequence to that of the others.

105.08 CONSTRUCTION STAKES, LINES AND GRADES

- A. The Contractor shall notify the Engineer at least 7 days before starting work in order that the Engineer may take necessary measures to ensure the preservation of survey monuments and bench marks. The Contractor shall not disturb permanent survey monuments or bench marks without the consent of the Engineer, and shall bear the

expense of replacing any that may be disturbed without permission. Replacement shall be done only by the Engineer.

- B. When a change is made in the finished elevation of the pavement of any roadway in which a permanent survey monument is located, the Contractor shall adjust the monument cover to the new grade unless otherwise specified.
- C. The Contractor shall preserve property line and corner survey markers except where their destruction is unavoidable, and the Contractor is proceeding in accordance with accepted practice. Markers that otherwise are lost or disturbed by Contractor's operations shall be replaced at the Contractor's expense by a Registered Land Surveyor.
- D. Except for private contracts, the Engineer will perform and be responsible for the accuracy of surveying adequate for construction. The Contractor shall be responsible for preserving construction survey stakes and marks for the duration of their usefulness. If any construction survey stakes are lost or disturbed and need to be replaced, such replacement shall be by the Engineer at the expense of the Contractor.
- E. The Contractor shall notify the Engineer at least 2 working days before Contractor will require survey services in connection with the laying out of any portion of the work. The Contractor shall dig all holes necessary for line and grade stakes.
- F. The Engineer will furnish and set construction stakes establishing lines and grades for street excavation, finished base gravel, curb and gutter, walks, structures, and utilities, and will furnish the Contractor all the necessary information relating to the lines and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall govern and execute the work.
- G. The line and grade stakes will be offset from the construction area. The stakes will show the offset distance, stationing, and required cut or fill to the finished grade or flow line as indicated on the plans. Grade stakes shall be set by the Engineer to the finished grade of the subgrade and also of the base gravel and the tops of these stakes marked blue or red. All stakes and grade shall be set with a surveyor's level or transit.
- H. The Contractor shall construct the work in accordance with the Engineer's stakes and marks, making use of them before they are disturbed, and shall be charged with full responsibility for conformity and agreement of the work with such stakes and marks. The Contractor shall be held responsible for the preservation of all stakes and marks, and if, in the opinion of the Engineer, any of the stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them shall be charged against, and deducted from, the payment for the work.
- I. Surveying by private engineers on work under the control of the Contracting Agency shall conform to the quality and practice required by the Engineer.
- J. Work upon completion shall conform to the lines, elevations, and grades shown on the plans, or as ordered by the Engineer.
- K. Three consecutive points set on the same slope shall be used together so that any variation from a straight grade can be detected. Any such variation shall be reported to the Engineer. In the absence of such report, the Contractor shall be responsible for any error in the grade of the finished work.
- L. Grades for underground conduits will be set at the surface of the ground. The Contractor shall transfer them to the bottom of the trench.

105.09 BLANK**105.10 DUTIES OF THE INSPECTOR**

- A. Inspectors for the Contracting Agency will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector will not be authorized to issue instructions contrary to the plans and specifications, or to act in any capacity for the Contractor.

105.11 INSPECTION

- A. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be provided acceptable access to all parts of the work and shall be furnished with such information and assistance by the Contractor as required to make a complete and detailed inspection.
- B. Any work done or materials used without inspection by an authorized Contracting Agency representative may be ordered removed unless the material meets the specifications and shall be replaced at no additional cost to the Contracting Agency unless the Contracting Agency representative failed to inspect after having been given notice in writing that the work was to be performed. If the noninspected work or material proves acceptable the work or material may remain, but any expenses entailed in a late inspection shall be the Contractor's.
- C. If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing and the replacing of the covering, or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing and replacing of the covering, or making good of the parts removed will be at no additional cost to the Contracting Agency.
- D. When facilities of any unit of government or political subdivision or of any railroad corporation or public utility corporation are adjusted or constructed as a part of the work covered by this contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad corporation or public utility corporation a party to this contract, and shall in no way interfere with the rights of either party thereunder.

105.12 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK

- A. All work which does not conform to the requirements of the contract will be considered as unacceptable work, unless otherwise determined acceptable under the provisions in Subsection [105.03](#), "Conformity with Plans and Specifications."
- B. Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause, found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner.
- C. Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, or as given except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions

of the contract. Work so done may be ordered removed or replaced at no additional cost to the Contracting Agency.

- D. Upon failure on the part of the Contractor to comply forthwith with any order of the Engineer, made under the provisions of this article, the Contracting Agency will have authority to cause unacceptable work to be remedied or removed or replaced and unauthorized work to be removed and to withhold the costs from any money due or to become due to the Contractor.

105.13 LOAD AND SPEED RESTRICTIONS

- A. The Contractor shall be responsible for all damage to the work caused by Contractor's hauling equipment.
- B. In hauling material for incorporation in portions of the project, loads which are in excess of the limits set by the Contracting Agency will not be permitted on any existing bridge or new and existing bituminous base and surface, cement treated base, or Portland cement concrete paving which is to remain in place for vehicular traffic within the project or between the project and the pits or other sources of materials. Load limits established by the Contracting Agency for the project shall be complied with regardless of the source of materials, whether from described pits, approved pits, or commercial sources. Unless otherwise stated in the Special Provisions, the maximum loads shall not exceed the limits set forth in Chapter 484, "Traffic Laws," of the Nevada Revised Statutes and all acts amendatory thereto or supplementary thereto.
- C. Construction loads greater than legal loads may be carried over any new bridge structure within the project providing the Contractor complies with all of the following limitations and provisions:
 - 1. Concrete in any such structure shall have attained designed strength as shown on the structure plans.
 - 2. The gross load of the vehicle shall not exceed 108,000 pounds.
 - 3. Gross load on any individual axle shall not exceed 48,000 pounds.
 - 4. The gross load on any individual set of tandem axles spaced not more than 6 feet apart shall not exceed 72,000 pounds.
 - 5. The center to center spacing of individual axles or center to center spacing of pairs of tandem axles shall not be less than 14 feet.
 - 6. No more than one lane of vehicles shall operate over any structure.
 - 7. The speed of any vehicle approaching or traveling on any structure shall not exceed 10 mph.
 - 8. The roadway surface approaching any structure shall be kept smooth and uniformly graded for 150 feet each side of the structure and shall be maintained to provide a uniform transition onto the structure.
 - 9. A cover of 6 inches \pm 1 inch shall be placed and maintained on the decks of all structures. Cover material shall not include rocks of diameter greater than 2 inches.
- D. The limitations specified in items 2, 3, 4, 5, 6, 7, 8, and 9 above may be waived for all reinforced concrete box culverts providing that the depth of fill compacted and in place over the reinforced concrete box culvert is equal to or greater than the distance between

inside faces of outside walls measured along center line of roadway. Fill may be placed not to exceed profile grade elevation.

- E. Construction loads greater than legal loads may be carried over structures within the project which have spans of 10 feet to 20 feet only when the Contractor complies with the above Subparagraph C, numbers 3 through 9, inclusive; however, the limitations as set forth in Subparagraph C, numbers 3 through 5, inclusive, may be waived by the Engineer for reinforced concrete box structures which are adequately supported by shoring. The Contractor shall submit Contractor's proposed shoring details and the actual loads and axle spacings to the Engineer for review prior to the planned hauling. Approval will be based on a review of the shoring details and a physical inspection of the shoring complete and in place.
- F. The Engineer shall make sufficient checks to satisfy Engineer that the Contractor is complying with all limitations, and any violation shall result in denying the Contractor use of the structure until the violation has been corrected to the satisfaction of the Engineer.
- G. The provision that the Contractor may haul construction loads greater than legal loads on new structures shall not relieve the Contractor of Contractor's responsibility for all damage caused by Contractor's hauling equipment.
- H. The Engineer may, for the protection of the traveling public, establish speed limits on or adjacent to the project. Such limitations of speed shall be strictly observed by the Contractor.

105.14 MAINTENANCE DURING CONSTRUCTION

- A. The Contractor shall maintain the work during construction and until the project is accepted, except as provided for in Subsections [104.04](#), "Maintenance of Traffic," and [107.15](#), "Relief from Maintenance and Responsibility." This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway and structures are at all times, to be kept in a condition satisfactory to the Engineer.
- B. In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.
- C. Except as provided for in Subsections [104.04](#), "Maintenance of Traffic," and [107.15](#), "Relief from Maintenance and Responsibility," all costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various pay items and the Contractor will not be paid an additional amount for such work.

105.15 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE

- A. If the Contractor, at any time, fails to comply with the provisions of Subsection [105.14](#), "Maintenance During Construction," the Engineer will immediately notify the Contractor in writing of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from money due or to become due the Contractor.
- B. If a condition develops that is dangerous to public safety in the opinion of the Engineer, such condition may be immediately remedied with whatever means is available and the cost of this maintenance will be deducted from money due or to become due to the Contractor.

105.16 FINAL ACCEPTANCE

- A. Upon due notice from the Contractor of presumptive completion of the entire project, the Engineer will make an inspection and if all construction and final cleanup provided for and contemplated by the contract are found completed to Engineer's satisfaction, that inspection shall constitute the final inspection and the Engineer will so advise the governing body or commission, who will notify the Contractor in writing of the acceptance of the contract as of the date of the final inspection. Such notice will not be given to the board or commission until all work has been completed to the satisfaction of the Engineer.

105.17 CLAIMS FOR ADJUSTMENT AND DISPUTES

- A. If, in any case, the Contractor deems that additional compensation is due Contractor for work or material not clearly covered in the contract or not ordered by the Engineer as extra work as defined herein, the Contractor shall notify the Engineer in writing of Contractor's intention to make claim for such additional compensation before Contractor begins the work on which Contractor bases the claim. If such notification is not given, and the Engineer is not afforded proper facilities by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, shall not in any way be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the Engineer, is found to be just, it will be paid as extra work as provided herein for "Force Account" work. Nothing in this subsection shall be construed as establishing any claim contrary to the terms of Subsection [104.02](#), "Increased or Decreased Quantities and Change in Character of Work."
- B. For all claims, the Contractor shall certify in writing that the claim is made in good faith, that the supporting data are accurate and complete to the best of Contractor's knowledge and belief, and that the amount requested accurately reflects the Contract adjustment for which the Contractor believes the Contracting Agency is liable. Subcontractor claims shall not be considered except as submitted by the Contractor as the Contractor's claims.
- C. Any controversy or claim arising out of or relating to this contract which cannot be resolved by mutual agreement shall be settled by arbitration in accordance with the Rules of the American Arbitration Association.

SECTION 106

CONTROL OF MATERIALS

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS

- A. The Contractor shall furnish all materials required to complete the work, except materials that are designated in the Special Provisions to be furnished by the Contracting Agency as specified in Subsection [106.11](#), "Contracting Agency Furnished Materials."
- B. No materials or supplies under this contract shall be purchased by the Contractor or by any subcontractor subject to any chattel mortgage, conditional sale contract or other security interest, or other agreement by which an interest is retained by the seller. The Contractor warrants that Contractor has good title to all materials and supplies used by the Contractor in the work, free from all liens, claims, or encumbrances.
- C. Only materials conforming to the requirements of the specifications shall be incorporated in the work except as provided in Subsection [105.03](#), "Conformity With Plans and Specifications."
- D. The materials furnished and used shall be new, except as may be provided elsewhere in these specifications, on the plans or in the Special Provisions. The materials shall be manufactured, handled, and used in a workmanlike manner to ensure completed work in accordance with the plans and specifications.
- E. The Contractor shall furnish the Engineer a list of the Contractor's sources of materials. The list shall be submitted to the Engineer prior to any official "Notice to Proceed" and in sufficient time to permit proper inspecting and testing of materials to be furnished from such listed sources in advance of their use.
- F. The listings of materials that are posted on the Interagency Quality Assurance Committee (IQAC) web page are automatically considered a qualified source. However, this does not remove the responsibility of the Contractor to provide inspection and testing on the project as specified herein. The address for the IQAC webpage is:
http://www.accessclarkcounty.com/depts/public_works/pages/iqac.aspx
- G. If it is found after trial that sources of supply for previously approved materials do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, which includes IQAC listed materials, the Contractor shall furnish satisfactory materials from other sources.
- H. The Contractor shall furnish without charge such samples as may be required by the Engineer. The primary inspection and testing shall be made by the Contractor or the Contractor's designated representative, with Engineer oversight. However, it is understood that such inspections and tests, if made at any point other than the point of incorporation in the work, in no way shall be considered as a guarantee of acceptance of such materials nor of continued acceptance of material presumed to be similar to that upon which inspections and tests have been made.
- I. Manufacturer's warranties, guarantees, instruction sheets, and parts lists, which are furnished with certain articles or materials incorporated in the work, shall be delivered to the Engineer before acceptance of the completed contract.
- J. Contractor's reports and records of inspections made and tests performed shall be submitted to the Engineer as required in these specifications. The Engineer's inspection

and testing records, when available at the site of the work, may be examined by the Contractor.

106.02 LOCAL MATERIALS

- A. Local material is defined as rock, sand, gravel, earth, or other mineral material, other than local borrow or selected material, obtained or produced from sources in the vicinity of the work specifically for use on the project. Local material does not include materials obtained from established commercial sources.
- B. Local materials shall be furnished by the Contractor from any source the Contractor may elect, except when a mandatory source is designated in the Special Provisions.
- C. Aggregates for base, surface, and concrete may be the products of approved commercial producers, provided they meet specification requirements.
- D. The furnishing of local materials from any source is subject to the provisions of Subsection [102.05](#), "Examination of Plans, Specifications, Contract Documents, and Site of Work," and Subsection [106.03](#), "Possible Local Material Sources." Material deposits shall not be excavated at locations where their resulting scars will present an unsightly appearance from any street or highway, unless such excavation is approved in writing by the Engineer.
- E. Generally, local material deposits will not be approved if located within 1,000 feet of right-of-way line. In any case the Contractor's pit operations shall not encroach within 25 feet of the right-of-way. Payment will not be made on material obtained in violation of these provisions.
- F. The Contractor shall, at no additional cost to the Contracting Agency, make any and all arrangements necessary for hauling over local, public, or private roads or property from any source. Full compensation for furnishing all labor, materials, tools, equipment, and incidentals; for doing all the work involved in conforming to the provisions in this subsection; and for furnishing and producing materials from any source shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed.
- G. The Contractor or the Contractor's representative shall attest to the content of the submitted materials that have been reviewed against the Contract Documents, and that the materials are in compliance thereto. Submitted materials that are to be evaluated as "Or Equal" or "Substitution" shall include sufficient information to enable the Engineer to make the determination for approval.

106.03 POSSIBLE LOCAL MATERIAL SOURCES

- A. If the Contractor desires to use materials from local sources other than those described in Subsection [102.05](#), "Examination of Plans, Specifications, Contract Documents, and Site of Work," the Contractor shall, at no additional cost to the Contracting Agency, acquire the necessary right to take material and shall obtain all other necessary permits and approvals and shall comply with all the requirements and stipulations in effect by other governing agencies having jurisdiction over the area, and pay all costs involved, including any which may result from an increase in length of haul. All costs of exploring and developing, including inspection and testing, such alternate sources shall be borne by the Contractor and the use of material from such sources will not be permitted until representative samples taken by the Engineer have been approved and written authority issued for the use thereof.

- B. The Contractor's attention is especially directed to Title 43, "Code of Federal Regulations," Part 23, "Surface Exploration, Mining and Reclamation of Lands," which pertains to all exploration, developing, and obtaining material from said alternate deposits located upon land under the jurisdiction of the Bureau of Land Management.
- C. Where the Contracting Agency has made arrangements with owners of land in the vicinity of a project for obtaining material from an owner's property, such arrangements are made solely for the purpose of providing all bidders an equal opportunity to obtain material from such property. Bidders or contractors may, upon written request, inspect the documents evidencing such arrangements between property owners and the Contracting Agency. The Contractor may, if the Contractor so elects, exercise any rights that have been obtained, which may be exercised by a Contractor under such arrangements, subject to and upon the conditions hereinafter set forth.
- D. Such arrangements are not a part of the contract and the Contracting Agency assumes no responsibility to the bidder or Contractor whatsoever in respect to the Contracting Agency's arrangements made with the property owner to obtain materials therefrom and that the Contractor shall assume all risks in connection with the use of such property, and there is no warranty or guarantee, either expressed or implied, as to the quality or quantity of materials that can be obtained or produced from such property or the type or extent of processing that may be required in order to produce material conforming to the requirements of the specifications.
- E. In those instances in which the Contracting Agency has designated optional or mandatory local material sources in the Special Provisions, this may include the documents setting forth the arrangements made with some of the property owners for obtaining material from such owners' properties. The inclusion of such documents therein shall not in any respect operate as a waiver of any of the provisions in this section concerning said documents.
- F. The bidder or Contractor is cautioned to make such independent investigation and examination as the bidder or Contractor deems necessary to satisfy bidder or Contractor as to the quality and quantity of materials available from such property, the type and extent of processing that may be required in order to produce material conforming to the requirements of the specifications and the rights, duties, and obligations acquired or undertaken under such an arrangement with the property owner.
- G. Notwithstanding that the Contractor may elect to obtain materials from any such property owner's property, no material may be obtained from such property unless the Contractor has first either:
 - 1. Executed a document that will guarantee to hold such owner harmless from all claims for injury to persons or damage to property resulting from the Contractor's operations on the property owner's premises and also agreed to conform to all other provisions set forth in the arrangement made between the Contracting Agency and the property owner. Said document will be prepared by the Engineer for execution by the Contractor, or
 - 2. Entered into an agreement with the owner of the material source on any terms mutually agreeable to the owner and the Contractor, provided that the Contractor shall furnish to the Engineer a release, in a form satisfactory to the Engineer, executed by the owner, relieving the Contracting Agency of any and all obligations under the Contracting Agency's arrangements with the owner.
- H. If the Contractor elects to obtain material under G.1, the use of such site shall be subject to the terms, conditions, and limitations of the arrangement made between the property

- owner and the Contracting Agency and the Contractor shall pay such charges as are provided for in the arrangement made by the Contracting Agency with the property owner.
- I. If the Contractor elects to obtain material under G.2, the Contractor shall pay such charges as are provided for in the agreement between the owner and the Contractor.
 - J. Unless otherwise provided and before execution of the contract, the Contractor shall submit written evidence that the owner of the material source is satisfied that the Contractor has satisfactorily complied with the provisions of either (a), the arrangement between the Contracting Agency and the owner, or (b), the agreement between the owner and the Contractor as the case may be.
 - K. Where the Contracting Agency has obtained the right to remove materials from lands owned or controlled by the U.S. Government, by withdrawal or otherwise, and these areas are set forth as optional or mandatory local material sources in the Special Provisions, the Contractor on the project may enter and remove materials for use on subject project only without further permission. The Contractor may not enter on or remove materials from any other areas withdrawn or otherwise obtained by the Contracting Agency from the U.S. Government which are not specifically designated for the project without prior written approval from the Contracting Agency.
 - L. Should the Contractor enter upon any of the areas withdrawn or otherwise obtained by the Contracting Agency from the U.S. Government, it shall be the Contractor's responsibility to determine the rights of others in the area. The Contractor shall not encroach on easements of others without their written permission and shall assume the responsibility for any damages due to the Contractor's entering said area. In addition, the Contractor shall be bound by the terms, conditions, and reservations contained in the approved application for withdrawal.
 - M. Full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and producing specified materials from possible local material sources, including the construction of any access roads or fences and any clearing, grubbing, and stripping of material sources, and all processing of whatever nature and extent required, shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed.

106.04 SAMPLES AND TESTS

- A. Sampling for final acceptance of materials will be as required in the appropriate specifications sections and in general shall comply with the AASHTO requirements, where applicable, and with the following sampling criteria:
 - 1. Aggregates for roadmix bituminous mixtures (including base or surface) will be sampled after the material has been placed on the roadbed and processed and prior to adding the bituminous binder.
 - 2. Aggregate for plantmix bituminous open-graded will be sampled from the laydown machine, or by "belt-cut" sample at the production plant at the Engineer's discretion.
 - 3. Aggregate for screenings will be sampled from the loaded truck just prior to placing, or by "belt-cut" sample at the production plant at the Engineer's discretion.
 - 4. Aggregate for plantmix bituminous mixtures (base or surface) will be sampled for acceptance behind the paver. Samples for plasticity tests will be taken at the bins.

5. Sampling of bituminous materials, intended for use in prime, tack or seal coats, surface treatments, and base, binder, or surface course mixtures shall be done after the bituminous material has arrived at job destination and before or at the time of unloading the materials.
 - a. Two samples shall be taken from each railroad tank car or truck transport of material by the Contractor or the Contractor's designated representative under the observation of and complying with the requirements of AASHTO T 40 in a manner approved by the Engineer. Where delivery is made in smaller hauling units than those cited above such as a distributor, or where the contents of a storage tank are sampled, the required 2 samples shall be taken to represent a maximum of 10,000 gallons. The Contractor shall take the samples during the established job working hours, unless arrangements are made for a representative of the Contracting Agency to witness the taking of the samples at another time.
 - b. All sampling devices and sample containers shall be furnished by the Contractor. Immediately after filling the sample container, it shall be tightly sealed, properly marked for identification, and presented to the Engineer.
 - c. One of the 2 samples, taken from each load, shall be submitted to the Contractor's Material Source laboratory for testing and the other sample retained by the Engineer. If the first sample tested complies with requirements, the second may be discarded.
 - d. Where less than 80 percent of the asphalt deliveries are used on the project, samples shall be taken just prior to delivery to the mixer. Samples shall be taken for every 25 tons of asphalt delivered to the project.
6. Tests for the aforementioned materials produced under conditions other than contemplated herein shall be taken at the time and place deemed by the Engineer to be most appropriate.

106.05 CERTIFICATE OF COMPLIANCE

- A. The Engineer may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance stating that the materials involved comply in all respects with the requirements of the specifications. The certificates shall be signed by the manufacturer of the material or the fabricator of assembled materials. A Certificate of Compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the certificate with attached applicable test results for that lot in accordance with the specification section.
- B. All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the work which conforms to the requirements of the plans and specifications and any such material not conforming to such requirements will be subject to rejection whether in place or not.
- C. The Contracting Agency reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.
- D. The form of the Certificate of Compliance and its disposition shall be as directed by the Engineer.

106.06 CITED SPECIFICATIONS

- A. The Nevada Department of Transportation has developed test methods for testing the quality of materials and work. These test methods are identified by the prefix Nev. followed by the serial number. Copies of individual test methods are available at the Materials Division, Nevada Department of Transportation, Carson City, Nevada.
- B. Whenever a reference is made in the specifications to a test method by Nev. or Cal. number, it shall mean the test method in effect on the date of the advertisement for bid.
- C. Whenever a reference is made in the specifications to a specification or test designation either of ASTM International, AASHTO, federal specifications, or any other recognized national organization, and the number or other identification accompanying the test designation representing the year of adoption or latest revision of the test is omitted, it shall mean the test method in effect on the date of advertisement for bid.
- D. When requested by the Engineer, the Contractor shall furnish, without charge, samples of all materials entering into the work, and no material shall be used prior to approval by the Engineer, except as provided in Subsection [106.05](#), "Certificate of Compliance." Samples of material from local sources shall be taken by or in the presence of the Engineer; otherwise, the samples will not be considered for testing.

106.07 PLANT INSPECTION

- A. The Engineer may inspect the production of material or the manufacture of products at the source of supply. The Contractor and material producer shall assure the Engineer of their cooperation and assistance to perform plant inspection prior to production of materials for the project. The Engineer or the Engineer's authorized representative shall have free entry at all times to such parts of the plant as concerns the manufacture or production of the materials. Adequate facilities shall be furnished free of charge to make the necessary inspection.
- B. It is understood that the Contracting Agency reserves the right to retest all materials prior to incorporation into the work which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of these specifications, or the requirements of the contract documents.

106.08 STORAGE OF MATERIALS

- A. Materials shall be so stored as to ensure the preservation of their quality and fitness for the work. When considered necessary by the Engineer, materials shall be stored in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and shall be covered when directed.
- B. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and materials shall meet the requirements of the specifications at the time of this proposed use. Stored materials shall be located so as to facilitate their prompt inspection.
- C. Upon approval of the Engineer, that portion of the right-of-way not required for public travel may be used for storage purposes and for placing of the Contractor's plant and equipment, but any additional space required therefor shall be provided by the Contractor at no additional cost to the Contracting Agency. Private or public property shall not be used for storage purposes without written permission of the owner or lessee.

- D. All storage sites shall be restored to their original condition by the Contractor at no additional cost to the Contracting Agency. This shall not apply to the stripping and storing of top soil or to other material salvaged from the work or specifically prescribed under the specifications. Construction materials may not be stored in streets, roads, or highways for more than 5 days after unloading. All materials or equipment not installed or used in the construction within 5 days after unloading shall be stored elsewhere by the Contractor at no additional cost to the Contracting Agency unless the Contractor is authorized additional storage time.
- E. Construction equipment shall not be stored at the work site before its actual use on the work nor for more than 5 days after it is no longer needed on the work unless the Contractor is authorized additional storage time. Time necessary for repair or assembly of equipment may be authorized by the Engineer.
- F. Excavated material, except that which is to be used as backfill in the adjacent trench, may not be stored in public streets, roads, or highways unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

106.09 HANDLING MATERIALS

- A. All materials shall be handled in such manner as to preserve their quality and fitness for the work.
- B. Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operation.

106.10 GUIDANCE ANALYSIS OF NONCOMPLYING MATERIALS

- A. In the event of a non-compliance of a produced or placed material, the Contractor is responsible for submitting a recommendation report to the Engineer for the determination of the basis of acceptance of the material by the Engineer based on AASHTO R-9, this section, and/or other industry practices as approved by the Engineer. This report shall be performed by a Nevada Professional Engineer. The receiving of the report by the Engineer does not imply acceptance of the report recommendations.
- B. The policy of the Engineer is that a project shall have been constructed "... in reasonably close conformity with the approved plans and specifications..." to be eligible for full payment of the material and installation. However, there will be instances when test results, as a result of the above noted variability may indicate apparent nonconformance to the specification limits, yet the construction product may be acceptable for the use intended at full or reduced pay. In these cases, an analysis of the materials and/or materials test results will be necessary by the Contractor through a professional engineer before payment is made.
- C. As a general guidance and unless otherwise stipulated in other specification sections or contract Special Provisions, if more than 10 percent of the test values for any construction product are outside of the applicable specifications, there may be a question of "reasonably close conformity." In these cases, an analysis of the test values should be made to determine the magnitude and extent of the nonconforming materials.

106.11 CONTRACTING AGENCY FURNISHED MATERIAL

- A. The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Contracting Agency. Material furnished by the Contracting Agency will be delivered or made available to the Contractor at the points specified in the Special Provisions.
- B. The cost of handling and placing all materials after they are furnished to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.
- C. The Contractor will be held responsible for all material furnished to the Contractor, and deductions will be made from any money due to the Contractor to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges. The responsibility by the Contractor includes any project inspection and testing that is required in these specifications.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 LAWS TO BE OBSERVED

- A. The Contractor shall keep fully informed of all federal and state laws, all local bylaws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. The Contractor shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders, and decrees, and shall protect and indemnify the Contracting Agency and its representative against any claim or liability arising from or based on the alleged violation of any such law, bylaw, ordinance, regulation, order, or decree, whether by the Contractor, the Contractor's employees, or agents.

107.02 PERMITS, LICENSES, AND TAXES

- A. The Contractor shall obtain all permits and licenses, and give all notices necessary and incident to the due and lawful prosecution of the work, including vehicular registration or prorate registration and carrier licensing as applicable. Privilege taxes are in addition to the above fees.

107.03 PATENTED DEVICES, MATERIALS, AND PROCESSES

- A. If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the Contracting Agency, and affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Contracting Agency for any costs, expenses, and damages which the Contracting Agency may be obliged to pay by reason of any alleged infringement, at any time during the prosecution or after the completion of the work.

107.04 RESTORATION OF SURFACES OPENED BY PERMIT

- A. The right to construct or reconstruct any utility service in the public right-of-way, or to grant permits for same, at any time, is hereby expressly reserved by the Contracting Agency or the proper authorities of the municipality or other political subdivision in which the work is done and the Contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.
- B. Any individual, firm, or corporation wishing to make an opening in the highway or street must secure a permit from the proper authority. The Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highways or streets. The Contractor shall, when ordered by the Engineer, make in an acceptable manner, all necessary repairs due to such openings, and such necessary work will be paid for as extra work, or as provided in these specifications, and will be subject to the same conditions as original work performed.
- C. The Contracting Agency, the Contractor, and each of such workmen, contractors, and others shall coordinate their operations and cooperate to minimize interference.

- D. The Contractor shall absorb in the Contractor's bid all costs involved on the Contractor's part as a result of coordinating the Contractor's work with others. The Contractor will not be entitled to additional compensation from the Contracting Agency for damages resulting from such simultaneous, collateral, and essential work. If necessary to avoid or minimize such damage or delay, the Contractor shall redeploy the Contractor's work force to other parts of the work.
- E. Should the Contractor be delayed by the Contracting Agency, and such delay could not reasonably have been foreseen and prevented by the Contractor, the Engineer will determine the extent of the delay, the effect of the delay on the project as a whole, and recommend to the Board any time extension indicated.

107.05 BLANK

107.06 SANITARY PROVISIONS

- A. The Contractor shall provide and maintain in a neat, sanitary condition, such accommodations for the use of the Contractor's employees as may be necessary to comply with the requirements and regulations of the Southern Nevada Health District and of other bodies or tribunals having jurisdiction thereover. The Contractor shall commit no public nuisance.

107.07 TRAFFIC AND ACCESS

- A. The Contractor's operations shall cause no unnecessary inconvenience. The access right of the public shall be considered at all times. Unless otherwise authorized, traffic shall be permitted to pass through the work, or an approved detour shall be provided.
- B. Safe and adequate pedestrian and vehicular access shall be provided and maintained to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, hospitals, and establishments of similar nature. Access to these facilities shall be continuous and unobstructed unless otherwise approved by the Engineer.
- C. Safe and adequate pedestrian zones and pedestrian crossings of the work at intervals not exceeding 300 feet shall be maintained unless otherwise approved by the Engineer.
- D. Safe and adequate access shall be maintained to existing bus or transit stops throughout duration of road construction in accordance with the following minimum requirements:
 - 1. Unless otherwise specified in the Special Provisions, no public bus or transit stop shall be temporarily closed without the written consent of the Regional Transportation Commission of Southern Nevada (RTC) General Manager or the RTC General Manager's designee. The RTC shall be notified at least 10 working days prior to the proposed temporary closure of any bus or transit stop, including those listed in the Special Provisions.
 - 2. No bus stops at transfer points shall be closed during construction. Bus stops at transfer points can, however, be temporarily relocated with the approval of the RTC.
 - 3. If bus or transit stop is temporarily relocated, the existing bus or transit stop sign panels shall be relocated to temporary bus or transit stops and shall remain until temporary stop is removed. Temporary relocation of sign panels shall conform to Subsection [627.03.05](#), "Relocation."

4. The Contractor shall maintain access that is in conformance to the requirements of the Americans with Disabilities Act to and from bus or transit stops which remain open at all times during construction.
- E. Vehicular access to residential driveways shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time. If backfill has been completed to such extent that safe access may be provided, and the street is opened to local traffic, the Contractor shall immediately clear the street and driveways and provide and maintain access.
- F. The Contractor shall cooperate with the various parties involved in the delivery of mail and the collection and removal of trash and garbage to maintain existing schedules for these services.
- G. Grading operations, roadway excavation, and fill construction shall be conducted by the Contractor in a manner to provide a satisfactory surface for traffic. When rough grading is completed, the roadbed surface shall be brought to a smooth, even condition satisfactory for traffic.
- H. Unless otherwise authorized, work shall be performed in only one half the roadway at one time. One half shall be kept open and unobstructed until the opposite side is ready for use. If one half a street only is being improved, the other half shall be conditioned and maintained as a detour.
- I. The Contractor shall absorb in the Contractor's bid all costs for the above requirements.
- J. The Contractor shall comply with all applicable state, county, and city requirements for closure of streets. Traffic work zone technicians on the project shall be certified in the work zone traffic control at least at the "Technician" level by ATSSA, IMSA, or NICET. The Contractor shall provide barriers, guards, lights, signs, temporary bridges, flagmen, and watchmen, advising the public of detours and construction hazards. The Contractor shall also be responsible for compliance with additional public safety requirements that may arise during construction. The Contractor shall furnish and install, and upon completion of the work, promptly remove all temporary signs and warning devices.
- K. At least 48 hours in advance of closing, partially closing, or reopening any street, alley, or other public thoroughfare, the Contractor shall notify the Police, Fire, Traffic and Engineering Departments having jurisdiction and comply with their requirements, and notify the Regional Transportation Commission of Southern Nevada. Deviations shall first be approved in writing by the Engineer.
- L. All costs involved shall be absorbed in the Contractor's bid. All barricades, warning signs, lights, temporary signals, and other protective devices shall conform with the Traffic Control Plans for Highway Work Zones for the Clark County Area and the current edition of the Manual on Uniform Traffic Control Devices.

107.08 RELATIONS WITH RAILROADS

- A. **Definitions:** The following definitions shall apply to the terms as herein used:
 1. **Railroad:** The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed.
 2. **Chief Engineer:** The Chief Engineer of the railroad or the Chief Engineer's authorized representatives.
 3. **Railroad Crossing:** A crossing at grade of the tracks of a railroad and the highway.

4. **Grade Separation:** A permanent structure to effect the separation of grade between the highway and the railroad.

B. Work or Operations:

1. Work or operations on grade separations, railroad crossings, or upon railroad property shall be subject to inspection by the Chief Engineer and shall be conducted and performed in a manner satisfactory to the Chief Engineer.
2. Construction operations shall be so arranged and conducted as to ensure safe and uninterrupted operation of the railroad traffic. The Contractor shall be responsible for any damages which result either directly or indirectly from the Contractor's operations.
3. The Contractor shall notify the Chief Engineer in writing, at least 48 hours before starting any work in the proximity of the tracks, setting forth specifically the time at which it is planned to start such work.
4. Unless otherwise provided, the Contractor shall not pile or store any material, or park or use Contractor's equipment closer than 10 feet from the centerline of the tracks.
5. The track zone shall be kept clean of all loose material or debris at all times. The Contractor shall be responsible for any fouling of railroad ballast resulting from sandblasting and painting operations and shall reimburse the railroad for the replacement of all ballast so fouled.
6. In advance of any blasting, the Contractor shall notify the Chief Engineer in order that proper flagging protection may be provided by the railroad. Excavations in the proximity of the tracks shall be sheeted in a manner satisfactory to the Chief Engineer and plans therefor shall be submitted to and approved by the Chief Engineer before any such excavation is commenced.
7. The Contractor shall make arrangements with the railroad for crossing railroad tracks at locations other than existing public crossings and shall bear all costs relative thereto.
8. The Contractor shall submit detail plans of falsework and of forms for track spans and piers or abutments to the Chief Engineer and no work thereon shall be commenced unless and until such plans have been approved by the Chief Engineer. Falsework plans thus approved shall not be deviated from without permission of the Chief Engineer. The temporary vertical and horizontal clearances specified by the Chief Engineer in approving the plans shall be maintained at all times. In the case of impaired vertical clearances above the top of rail, the railroad shall have the option to install telltales, or other such protective devices the railroad deems necessary, for the protection of trainmen or rail traffic.
9. The Contractor shall comply with the rules and regulation of the railroad with respect to the Contractor's work or operation on or adjacent to railroad property. The Contractor shall arrange with the railroad for the services of such qualified railroad employees as the Chief Engineer may prescribe to protect and safeguard the railroad's property, engines, trains, and cars. The costs incurred for the services of such railroad employees as may be prescribed by the Chief Engineer for necessary safeguard and protection and the costs of installing telltales or other protective devices in the case of impaired vertical clearance, shall be borne by the Contractor without expense to the Contracting Agency or railroad. Payment for such services,

including compensation, insurance, vacation and holiday time, railroad retirement and unemployment taxes, health and welfare, accounting and billing charges, may be paid by the Contracting Agency directly to the railroad and the amount thereof shall be deducted by the Contracting Agency from money due or which may become due the Contractor under the awarded contract. Rates of pay for qualified railroad employees will be the railroad's rates for the various classes of labor customarily used and in effect at the time the work is performed. The Contractor's reimbursement for personnel and protective devices required as set forth herein shall be considered as included in the contract unit prices bid for other items of work.

10. Upon completion of the work covered by the awarded contract to be performed by the Contractor upon railroad's property, the Contractor shall promptly remove from the railroad's property all tools, equipment, and other materials, whether brought upon said property by the Contractor or any subcontractor, and shall cause said property to be left in a clean and presentable condition.

C. Work or Operations Performed by Railroad:

1. The railroad may undertake certain work or operations incident to the project which are the subject of an agreement between the Contracting Agency and the railroad. Details of such work or operations will be set forth in the Special Provisions and the Contractor shall discuss such items with the Chief Engineer in order to develop a plan whereby the Contractor and the railroad accomplish the work or operations in their logical sequence and order.
2. Movement or adjustment of telephone, telegraph, or signal facilities owned, operated, or maintained by the railroad and not otherwise provided for on the plans or in the Special Provisions shall be at the cost and expense of the Contractor.

- D. Insurance:** The Contractor shall provide and maintain during the effective life of the awarded contract such special or additional insurance as is required by Subsection [107.11](#), "Responsibility for Damage Claims," herein. The Contractor shall furnish such evidence as may be required that such insurance has been provided.
- E. Qualification:** As a prerequisite to award, the Contractor shall be satisfactory as to responsibility to perform work upon the railroad's property.
- F. Reference:** The provisions of Subsection [624.03.02](#), "Flaggers," Subsection [624.03.03](#), "Pilot Cars," Subsection [107.11](#), "Responsibility for Damage Claims," and the Special Provisions shall inure directly to the benefit of the railroad.

107.09 LIABILITY INSURANCE

A. Contractor's Public Liability and Property Damage Liability Insurance:

1. The Contractor shall provide and maintain during the effective life of the awarded contract, regular Contractor's Public Liability and Property Damage Liability Insurance, the limits for which may be set by the Special Provisions to protect the Contractor and all of the Contractor's construction subcontractors from claims for personal injury, accidental death, and damage to property, which may arise from operations under said contract, whether such operations be by the Contractor or by such subcontractor or by anyone directly or indirectly employed by either of them. The Successful Bidder shall furnish the Contracting Agency a policy or certificate of liability insurance in which the Contracting Agency shall be named insured or be named as an additional insured with the Contractor. The Successful Bidder shall

also furnish a Certificate of Workman's Compensation Insurance, Nevada Industrial Commission.

2. Whenever construction operations covered under said contract are to be performed upon or in proximity to railroad property, the Contractor's Public Liability and Property Damage Insurance shall provide for limits of coverage not less than specified in the Railroad Protective Insurance Endorsement appended to the Special Provisions.
3. The Contractor shall furnish the Contracting Agency with 1 certified copy of all insurance required under this paragraph.

B. Railroad's Protective Public Liability and Property Damage Insurance:

1. In all cases where construction operations covered by the awarded contract are to be performed upon or adjacent to the property of the railroad, the Contractor shall furnish evidence to the Contracting Agency that, with respect to the operations the Contractor or any of the Contractor's subcontractors perform, the Contractor has provided for and in favor of the railroad a policy of Public Liability and Property Damage Insurance, to which is attached an endorsement, in the same form and with the same limits of coverage as the Railroad Protective Insurance Endorsement appended to the Special Provisions.
2. Such insurance shall apply only to that portion of the project upon or adjacent to the railroad property.
3. Railroad's Protective Public Liability and Property Damage Insurance shall be subject to approval by the railroad before any work is commenced on or adjacent to the railroad property.
4. Such insurance shall be carried, and the premiums therefor paid by the Contractor until all work required to be performed under the terms of said contract is satisfactorily completed as evidenced by the formal acceptance of the Contracting Agency and thereafter until all said tools, equipment, and materials have been removed from the property of the railroad and such property left in a clean and presentable condition. The insurance shall be non-cancelable and non-alterable for any cause whatsoever (including failure to pay premiums) either by the Contractor or by the insurance company without 30 days' written notice to the railroad and the Contracting Agency. In the event such insurance is canceled as herein provided, the Contractor shall provide other insurance, subject to the same conditions as provided herein, which shall be effective as of the day of such cancellation and cover the unexpired period of the term herein required. The Contractor shall furnish the Contracting Agency at the time of execution of said contract, 3 copies of each policy to which is attached an endorsement the same as the Railroad Protective Insurance Endorsement appended to the Special Provisions. Two copies of each of such policies shall be forwarded by the Contracting Agency to the Chief Engineer for the railroad's approval.

107.10 EXPLOSIVES

- A. Explosives may be used only when authorized in writing by the Engineer, or as otherwise stated in the Special Provisions. Explosives shall be handled, used, and stored in accordance with all applicable regulations.
- B. The Engineer's approval of the use of explosives shall not relieve the Contractor from the Contractor's liability for claims caused by the Contractor's blasting operations.

- C. All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than 1,000 feet from the road or from any building or camping area or place of human occupancy.
- D. The Contractor shall notify each public utility company having structures or pipelines in proximity to the site of the work of the Contractor's intention to use explosives. Such notice shall be given in writing a week in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

107.11 RESPONSIBILITY FOR DAMAGE CLAIMS

- A. The Contractor shall indemnify and save harmless the Contracting Agency, its officers, and its employees from all suits, actions, claims, losses, or expenses of any character brought because of any injuries or damages alleged to have been received or sustained by any person, persons, or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any claims or amount recovered under the "Nevada Industrial Insurance Act," or any other law, ordinance, order, or decree; and so much of the money due the Contractor under and by virtue of the contract as may be considered necessary by the Contracting Agency for such purpose, may be retained for the protection of the Contracting Agency; or in case no money is due, the Contractor's surety may be held until all such suits, actions, claims, losses, or expenses for the injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Contracting Agency; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that the Contractor is adequately protected by public liability and property damage insurance.
- B. Reimbursement to the Contractor by the Contracting Agency in whole or in part for costs of protecting traffic shall not serve to relieve the Contractor of the Contractor's responsibility as set forth in these specifications.
- C. The Contractor guarantees the payment of all just claims for materials, supplies, and labor and all other just claims against the Contractor or any subcontractor, in accordance with this contract.

107.12 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE

- A. The Contractor shall be responsible for the preservation from injury or damage resulting directly or indirectly from the work under the contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs and markers, etc., along and adjacent to the project, and shall use every precaution necessary to prevent damage to waterlines, sewers, and other underground structures, to poles, wires, cables, and other overhead structures, whether shown on the plans or not, shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location, and shall not remove them until directed. The Contractor shall not willfully or maliciously injure or destroy trees or shrubs, and the Contractor shall not remove or cut trees or shrubs without proper authority.
- B. The Contractor shall be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect, or misconduct in the Contractor's manner or method of executing said work, or at any time

due to defective work or materials, and such responsibility shall not be released until the project shall have been completed and accepted.

- C. The Contractor shall be responsible for the preservation of archeological and paleontological objects, including all ruins, sites, buildings, artifacts, fossils, or other objects of antiquity encountered during construction. When such objects are encountered, the Contractor shall immediately cease operations and notify the Engineer that such objects exist. Construction operations shall be rescheduled to avoid the section until the removal of the artifacts or the gathering of historical data has been accomplished by the appropriate authority. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper authorities. Such excavation will be considered and paid for in accordance with Subsection [104.03](#), "Extra Work."
- D. Extension of contract time will be allowed for any delay to the Contractor due to preservation of archeological and paleontological objects.
- E. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work, or in consequence of the nonexecution thereof on the part of the Contractor or the Contractor's agents, suppliers, or subcontractors, the Contractor shall restore at no additional cost to the Contracting Agency such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed, or the Contractor shall make good such damage or injury in an acceptable manner. In case of failure on the part of the Contractor to restore such property or make good such damage or injury within 10 days, the Contracting Agency may, upon 48 hours' written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary and the cost thereof shall be deducted from any money due, or which become due the Contractor under the contract.
- F. The Contractor shall restrict the movement of the Contractor's vehicles and other construction equipment and personnel to the construction area and designated roads. Every precaution shall be taken to prevent the marking of the natural ground with equipment tracks or other means outside of the staked area and in median areas where it is not required to disturb the existing ground. Where such markings of the natural ground are caused either by the Contractor's equipment, personnel, or operations, the Contractor, at no additional cost to the Contracting Agency, shall eradicate such marks to the satisfaction of the Engineer.
- G. All roads used for construction operations shall be spaced at least 1,000 feet apart from flat bottom ditches and material deposits, except that such roads may also be located in ditch and dike areas. When roads are located in ditch and dike areas, equipment shall not be allowed to travel outside the area occupied by said ditch or dike, except as provided for in Subsection [203.03.13](#), "Channels." The crossing of median areas shall be at structures or areas approved by the Engineer.
- H. Where there is a high potential for erosion and subsequent water pollution, the area of erosive land that may be exposed by construction operations at any one time shall be held to a minimum, and the duration of the exposure of the uncompleted construction to the elements shall be as short as practicable. Erosion control features shall be constructed concurrently with other work and at the earliest practicable time.
- I. Disturbance of the lands and of waters that are outside the limits of the construction as staked is prohibited, except as may be found necessary and approved by the Engineer.

107.13 FIRE PROTECTION

- A. There shall be no open burning unless approval has been given in writing by the Clark County Air Pollution Control Officer and the Engineer has concurred. Before setting any fires whatsoever, the Contractor shall notify the responsible agency having jurisdiction for the area concerned. The Engineer shall have authority to enforce correction of any condition which is, in the Engineer's opinion, unsafe.

107.14 DISPOSAL OF MATERIAL OUTSIDE PROJECT RIGHT-OF-WAY

- A. The Contractor shall make the Contractor's own arrangements for disposal of materials outside the project right-of-way at no additional cost to the Contracting Agency.
- B. When any material is to be disposed of outside the project right-of-way, the Contractor shall first obtain a written permit from the property owner on whose property the disposal is to be made, and the Contractor shall file in writing with the Engineer said permit or the certified copy thereof together with a written release from the property owner absolving the agency of any and all responsibility in connection with the disposal of material on said property.
- C. When material is disposed of as above provided and the disposal location is visible from the project, the Contractor shall dispose of the material in a neat and uniform manner to the satisfaction of the Engineer.
- D. Unless otherwise provided in the Special Provisions, full compensation for all costs involved in disposing of material as specified in this section, including all costs of hauling, shall be considered as included in the price paid for the contract items of work involving such materials and no additional compensation will be allowed therefore.

107.15 RELIEF FROM MAINTENANCE AND RESPONSIBILITY

- A. Upon the written request of the Contractor, or upon order of the Engineer, the Contractor may be relieved of the duty of maintaining and protecting certain portions of the work as described below, which have been completed in all respects in accordance with the requirements of the contract and to the satisfaction of the Engineer, and thereafter except with the Engineer's consent, the Contractor will not be required to do further work thereon. In addition, such action by the Engineer will relieve the Contractor of responsibility for injury or damage to said completed portions of the work resulting from use by the public traffic or from the action of the elements or from any other cause, but not from injury or damage resulting from the Contractor's own operations or from the Contractor's negligence.
- B. Portions of the work for which the Contractor may be relieved of the duty of maintenance and protection as provided in the above paragraph include but are not limited to the following:
 - 1. A bridge or other structure of major importance.
 - 2. A complete unit of a traffic control signal system or of a highway or street lighting system.
 - 3. Non-project facilities constructed for other agencies.
- C. However, nothing in this subsection providing for relief from maintenance and responsibility will be construed as relieving the Contractor of full responsibility for making good defective work or materials found at any time before the formal written acceptance of the entire project by the Contracting Agency.

107.16 CONTRACTOR'S RESPONSIBILITY FOR THE WORK AND MATERIALS

- A. Until the acceptance of the contract, the Contractor shall have the charge and care of the work and of the materials to be used therein (including materials for which the Contractor has received partial payment as provided in Subsection [109.06](#), "Partial Payments," or materials which have been furnished by the agency) and shall bear the risk of injury, loss, or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work, except as provided in Subsection [107.15](#), "Relief from Maintenance and Responsibility."
- B. The Contractor shall rebuild, repair, restore, and make good all injuries, losses, or damages to any portion of the work or the materials occasioned by any cause before its completion and acceptance and shall bear the expense thereof, except as otherwise expressly provided in Subsection [203.03.11](#), "Slides and Slipouts," and Subsection [619.05.01](#), "Payment," for Object Markers and Guide Posts, and except for such injuries, losses, or damages as are directly and proximately caused by acts of the federal government or the public enemy. The Contractor shall, at no additional cost to the Contracting Agency, provide suitable drainage for the project and erect such temporary structures as are necessary to protect the work or materials from damage.
- C. The suspension of the work from any cause whatever shall not relieve the Contractor of the Contractor's responsibility for the work and materials as herein specified. If ordered by the Engineer, the Contractor shall, at no additional cost to the Contracting Agency, properly store materials which have been fully or partially paid for and furnished by the Contracting Agency. Such storage by the Contractor shall be on behalf of the Contracting Agency and the Contracting Agency shall at all times be entitled to the possession of such materials, and the Contractor shall promptly return the same to the site of the work when requested. The Contractor shall not dispose of any of the materials so stored except on written authorization from the Engineer.

107.17 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICE

- A. At points where the Contractor's operations are adjacent to properties of railroad, telegraph, telephone, and power companies, or are adjacent to or in conflict with other property or utilities, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.
- B. The Contractor shall not begin any operations which may interfere with or impair the normal service being rendered by public or private utility operations, until such operators have been notified, and shall cooperate with the owners of any underground or overhead utilities in their removal and rearrangements operations in order that these operations may progress in a reasonable manner, and that duplication of rearrangements work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. The Contractor will be held responsible for the protection of the property of public or private utilities within the limits of the work.
- C. In general, the repair and adjustment of street structures such as waterlines, sewers, telephone, telegraph, gas, and electric lines, above or below the ground, will be made by the owners thereof as specified in Subsection [105.06](#), "Cooperation with Utilities." When included in the proposal, the adjustment of sewer manhole frames and covers, inlets and catch basin frames and covers and the like, will be within the Contractor's responsibility. The Contractor shall see that they are adjusted to conform to the lines, grades, and typical

cross sections as shown on the plans, or as prescribed, without respect to whether the repairs and the roughing-in work have been performed by the Contractor or others.

- D. Pipes or other construction shall be maintained in continuous service as far as practicable and shall be properly protected and supported. In no case shall interruption of the water service be allowed to exist outside of working hours.
- E. Fire hydrants shall be accessible at all times to the fire department. No material or other obstruction shall be placed closer to a fire hydrant than permitted by ordinances, rules, or regulations, or within 15 feet of the fire hydrant in the absence of such ordinances, rules, or regulations.
- F. The Contractor shall give notice in writing to the proper authorities in charge of streets, gas, water pipes, sewer lines, electric, and other conduits, railroads, poles, manholes, catch basins, and all other property that may be affected by the Contractor's operations, at least 48 hours before breaking ground.
- G. In the event of interruption to water or utility services as a result of accidental breakage, the Contractor shall promptly notify the proper authority. The Contractor shall cooperate with said authority in the restoration of service as promptly as possible.
- H. Attention is directed to Subsection [105.06](#), "Cooperation with Utilities."

107.18 FURNISHING RIGHT-OF-WAY

- A. The Contracting Agency will be responsible for the securing of all right-of-ways shown in the plans. Any exceptions will be indicated in the contract.

107.19 PERSONAL LIABILITY OF PUBLIC OFFICIALS

- A. In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the officers or employees of the Contracting Agency, either personally or as officials of the County or Municipality, it being understood that in all such matters they act solely as agents and representatives of the Political Subdivision.

107.20 NO WAIVER OF LEGAL RIGHTS

- A. The Contracting Agency shall not be precluded or estopped by any measurements, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefor, from showing the true amount and character of the work performed, and materials furnished by the Contractor, nor from showing that any such measurement, estimate, or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Contracting Agency shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the Contractor or the Contractor's sureties, or both, such damages as it may sustain by reason of the Contractor's failure to comply with the terms of the contract. Neither the acceptance by the Contracting Agency, or any representative of the Contracting Agency, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Contracting Agency, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

107.21 DUST CONTROL

- A. Dust that originates from the Contractor's operations, either inside or outside the right-of-way, shall be controlled at all times by the Contractor in accordance with federal, state, and local laws, ordinances, and regulations at the sole expense of the Contractor.
- B. A permit from the Clark County Air Pollution Officer shall be obtained by the Contractor prior to the start of construction operations.
- C. Reference is made to Section [637](#), "Pollution Control."

107.22 VIBRATORY EQUIPMENT OPERATIONS

- A. All construction activities involving vibratory equipment shall be conducted by the Contractor on a performance basis. The Contractor may be required to conduct impact assessment tests of the Contractor's vibratory equipment prior to initiation or during construction. The frequency and amplitude of the vibratory equipment shall be calibrated and used to measure ground velocity for conformance to the current regulatory limit of 0.5 inch per second peak ground velocity at the nearest affected structure. The measurements shall comply with the recommendations of the *Blasting Guidance Manual*, published in 1987 by the Office of Surface Mining and Enforcement.

SECTION 108

PROSECUTION AND PROGRESS

108.01 SUBLETTING OF CONTRACT

- A. If the bidder intends to sublet any portion of the work, the bidder shall furnish a list of the subcontractors as a material part of the bidder's sealed proposal on the form provided, listing a description of the work to be performed by each subcontractor. If the bidder does not intend to sublet any part of the work, the bidder shall insert the word "NONE" on the form provided. In the event that the prospective bidder fails to complete the subcontractor's list, either with the insertion of the bidder's intended subcontractors, or with the word "NONE," the bidder's proposal shall be rejected without consideration. The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of the Contractor's right, title, or interest therein, without prior written consent of the Contracting Agency and of the surety.
- B. Requests for permission to sublet, assign, or otherwise dispose of any portion of the contract shall be in writing and accompanied by a letter showing that the organization which will perform the work is particularly experienced for such work.
- C. Consent to sublet, assign, or otherwise dispose of any portion of the contract shall not be construed to relieve the Contractor of the Contractor's liability under the contract and bonds.
- D. All subcontractors and assignees of the prime or general Contractor shall be required to comply with the provisions of NRS 408.373, NRS Chapter 338, and all other applicable federal, state, and local laws or regulations in the same manner as the prime or general Contractor.
- E. Contract bid prices will prevail for purposes of computing the monetary value of all subcontracts.
- F. The Contractor shall perform with the Contractor's own organization, unless otherwise authorized by the Special Provisions, work amounting to not less than 25 percent of the combined value of all items of the work covered by the contract except as follows:
 - 1. Should the Contractor elect to furnish materials for work to be performed by an approved subcontractor, and the materials are not obtained from the same firm that is to perform the work of incorporating these materials into the project, the cost of the materials, when set forth in a written statement accompanying the subcontract agreement or contained therein, will be excluded from amounts applicable to the subcontracted percentage.
- G. When a firm both sells materials to a Contractor and performs the work of incorporating the materials into the project, these two phases of work must necessarily be considered a single subcontract.
- H. Roadside production of materials is construed to be the production of crushed stone, gravel, or other material with portable or semi-portable crushing, screening, or washing plants, established or reopened in the vicinity of the work for the purpose of supplying materials to be incorporated into the work on a designated project or projects. Roadside production of materials shall be considered subcontracting if performed by other than the Contractor.

- I. The Contracting Agency will not recognize any subcontractor on the work as a party to the contract. Nothing contained in any subcontract shall create any contractual relation between the subcontractor and the Contracting Agency. The Contractor will be held responsible for the progress of the work in accordance with the contract progress required.

108.02 NOTICE TO PROCEED

- A. The successful bidder agrees to conform to the following which shall govern the Physical Notice to Proceed for this project:
 1. Authorization to commence actual physical work shall be issued by the Contracting Agency.
 2. The authorization to proceed shall be given verbally to the successful bidder. The Contracting Agency shall confirm this authorization in writing.
 3. The verbal authorization to proceed shall have an actual start date for physical work to commence and a scheduled completion date.
 4. After the verbal Notice to Proceed has been issued by the Contracting Agency, failure of the successful bidder to commence work by the actual start date shall be grounds for breach of contract.
- B. A Material Notice to Proceed may be issued by the Contracting Agency subject to the same conditions as items 1, 2, and 3 of the Physical Notice to Proceed requirements. The maximum time allowed for acquisition of materials shall be the number of calendar days specified in the contract after verbal authorization has been given by the Contracting Agency.
- C. At the successful bidder's option, the successful bidder may elect to start work during the Material Notice to Proceed time. If the successful bidder elects to commence physical work prior to the calendar days of the Material Notice to Proceed expiration, the following shall apply:
 1. Once the actual date the successful bidder elects to enter the project and commence physical work, the time allotted for Physical Work shall commence.
 2. No stop orders shall be issued due to lack of materials that have not arrived.
 3. Any time remaining under the calendar day Material Notice to Proceed shall expire automatically at the end of the last calendar day for physical work to be completed.

108.03 PROSECUTION AND PROGRESS

- A. When required by the Engineer, the Contractor shall furnish the Engineer with a "Progress Schedule" for the Engineer's approval. The progress schedule may be used as the basis for establishing major construction operations and as a check on the progress of the work. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the Special Provisions. Should the prosecution of the work for any reason be discontinued, the Contractor shall notify the Engineer at least 24 hours in advance of resuming operations.

108.04 LIMITATION OF OPERATIONS

- A. The Contractor shall conduct the work in such a manner and in such sequence as will ensure the least interference with traffic. The Contractor shall have due regard to the

location of detours and to the provisions for handling traffic. The Contractor shall not open up work to the prejudice or detriment of work already started. The Engineer may require the Contractor to finish a section on which the work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

- B. No productive work will be required on Saturdays, Sundays, or holidays unless otherwise provided for in the Special Provisions. If, however, the Contractor elects to work on such days, those days worked will be charged as working days. The Contractor shall give the Engineer notice of the Contractor's intention to work on the aforementioned days at least 48 hours in advance of such work. Holidays are defined in Subsection [101.29](#), "Holidays."
- C. The Engineer is authorized to notify the Contractor in writing and require the Contractor to cease construction operations the day before, during, and the day after said holidays, or at any other time if the Contractor's operations are of such nature, the project is so located, or the traffic is of such volume that it is deemed expedient to do so.

108.05 CHARACTER OF WORKMEN; METHODS AND EQUIPMENT

- A. The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.
- B. Workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.
- C. Any person employed by the Contractor or by a subcontractor who, in the opinion of the Engineer, does not perform the Contractor's or subcontractor's work in a proper manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer.
- D. Should the Contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Contracting Agency may suspend the work by written notice until such orders are complied with.
- E. All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other improvement will result from its use.
- F. When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that the Contractor demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the requirements of the contract.
- G. When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use methods or types of equipment other than those specified in the contract, the Contractor may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the

reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements and with the concurrence of the Contracting Agency. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substituted method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

108.06 TEMPORARY SUSPENSION OF WORK

- A. The Engineer shall have the authority to suspend the work wholly or in part, for such period as the Engineer may deem necessary due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work. The Contracting Agency shall have the authority to suspend the work wholly or in part for such time as it may deem necessary, due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the contract. The Contractor shall immediately comply with the written order of the Engineer or Contracting Agency to suspend the work wholly or in part. The suspended work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing by the Engineer.
- B. In the event that a suspension of work is ordered as provided above, and should such suspension be ordered by reason of the failure of the Contractor to carry out orders or to perform any provision of the contract, or by reason of weather conditions being unsuitable for performing any item or items of work, which work, in the sole opinion of the Engineer, could have been performed prior to the occurrence of such unsuitable weather conditions had the Contractor diligently prosecuted the work when weather conditions were suitable, the Contractor, at no additional cost to the Contracting Agency, shall do all the work necessary to provide a safe, smooth, and unobstructed passageway through construction for use by public traffic during the period of such suspension as provided in Subsection [107.07](#), "Traffic and Access," and as specified in the Special Provisions for the work. In the event that the Contractor fails to perform the work above specified, the Contracting Agency will perform such work and the cost thereof will be deducted from money due or to become due the Contractor.
- C. In the event that a suspension of work is ordered by the Contracting Agency due to unsuitable weather conditions, and in the sole opinion of the Engineer, the Contractor has prosecuted the work with energy and diligence prior to the time that operations were suspended, the cost of providing a smooth, and unobstructed passageway through the work will be paid for as extra work as provided in Subsection [104.03](#), "Extra Work," or at the option of the Contracting Agency such work will be performed by the Contracting Agency at no cost to the Contractor.
- D. If the Engineer orders a suspension of all the work or a portion of the work which is the current controlling operation or operations, due to unsuitable weather or to such conditions as are considered unfavorable to the suitable prosecution of the work, the days on which the suspension is in effect shall not be considered working days as defined in Subsection [101.74](#), "Working Day." If a portion of work at the time of such suspension is not a current controlling operation or operations, but subsequently does become the

current controlling operation or operations, the determination of working days will be made on the basis of the then current controlling operation or operations.

- E. If a suspension of work is ordered by the Contracting Agency, due to the failure on the part of the Contractor to carry out orders given to perform any provision of the contract, the days on which the suspension order is in effect shall be considered working days if such days are working days within the meaning of the definition set forth in Subsection [101.74](#), "Working Day."
- F. In the event of a suspension of work under any of the conditions set forth in this section, such suspension of work shall not relieve the Contractor of the Contractor's responsibilities as set forth in Section [107](#), "Legal Relations and Responsibility to the Public."

108.07 PRECONSTRUCTION CONFERENCE

- A. After the contract has been awarded and prior to commencing work, the Contracting Agency may designate a time and place satisfactory to the Contractor for a preconstruction conference. At such time the Engineer will outline detailed requirements to be followed in performance of the contract.

108.08 DETERMINATION AND EXTENSION OF CONTRACT TIME

- A. The contract time for completion will be fixed by the Contracting Agency, and will be stated in the Special Provisions, either as a calendar date, or based on a number of working days, or on a specified number of calendar days. Attention is directed to Subsection [101.74](#), "Working Day."
- B. The Contractor shall perform the work in an acceptable manner within the time stated in the contract except that the contract time for completion may be adjusted as follows:
 - 1. If the satisfactory completion of the contract shall require performance of work in greater quantities than those set forth in the proposal, the time allowed for performance shall be increased in the same ratio as the final estimate bears to the original contract amount, except that the final monetary amount of any supplemental agreement or contract change order for which an extension of contract time was previously allowed shall be deducted from the final estimate prior to making the pro-rata time adjustment. The final monetary amount of supplemental agreements or contract change orders for which an extension of contract time has not been allowed will be included in the final estimate for making the pro-rata time adjustment. The amount for asphalt cements and liquid asphalts will not be considered in the original or the final estimates for determining time extensions.
 - 2. If delays beyond the Contractor's control are caused solely by action or inaction by the Contracting Agency, such delays will entitle the Contractor to an extension of time which will be based upon the effect of delays to the project as a whole and will not be granted for noncontrolling delays to minor included portions of work, unless it can be shown that such delays did, in fact, delay the progress of the product as a whole.
 - 3. When delays occur due to unforeseen causes beyond the control and without the fault or negligence of the Contractor, including, but not restricted to acts of God, acts of the public enemy, acts of government agency, fires, floods, epidemics, strikes, and freight embargoes, the time for completion shall be extended an amount determined by the Contracting Agency to be equivalent to the delays; provided,

however, written request for such extension of time is made by the Contractor within 10 calendar days after the beginning of such delay. No allowance shall be made for delay or suspension of the work due to fault of the Contractor.

- C. Certain critical materials such as steel, copper, aluminum, and bituminous products may be difficult to obtain due to a nationally recognized shortage or defense needs. The Contractor shall make every reasonable effort necessary to order and procure all such critical materials sufficiently in advance so as not to delay the completion of the project. Should a delay occur in obtaining critical materials that were properly ordered by the Contractor, the time for completion of the contract may be extended an amount determined by the Contracting Agency to be equivalent to the delay in project progress due to said delay in obtaining critical materials provided that:
1. The delay in furnishing critical materials was due to defense needs or nationally recognized shortage.
 2. The Contractor furnishes evidence to the Engineer's satisfaction that the Contractor had taken adequate steps for a guaranteed delivery date from the Contractor's supplier.
 3. The evidence shall contain certification of adequate steps for a guaranteed delivery by not less than 3 suppliers of the material or if 3 suppliers are not available, the Contractor shall so certify and supply certification from such suppliers as there are.
 4. That the Contracting Agency does not find a source when notified of the shortage by the Contractor.
 5. That the Contractor obtains such material from the first source available after such certification.
- D. The contract time shall begin as set forth in Subsection [108.02](#), "Notice to Proceed." When the final acceptance has been duly made by the Engineer as prescribed in Subsection [105.16](#), "Final Acceptance," the daily time charge shall cease.

108.09 FAILURE TO COMPLETE THE WORK ON TIME

- A. Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Contracting Agency of the administration of the contract, including engineering, inspection, and supervision will be increased as the time occupied in the work is lengthened. The public is subject to detriment and inconvenience when full use cannot be made of a project.
- B. Should the Contractor fail to complete the work within the time agreed upon in the contract or within such extra time as may have been allowed by increases in the contract or by formally approved extensions granted by the Contracting Agency, there shall be deducted from any money or amounts due or that may become due the Contractor, the sum set forth in the Special Provisions for each day the work shall remain uncompleted. This sum shall be considered and treated not as a penalty but as liquidated damages due the Contracting Agency from the Contractor by reason of inconvenience to the public, added cost of engineering and supervision, and other items which have caused an expenditure of public funds resulting from the Contractor's failure to complete the work within the time specified in the contract.
- C. Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been

extended, will in no way operate as a waiver on the part of the Contracting Agency of any of its rights under the contract.

- D. The Contracting Agency may waive such portions of the liquidated damages as may accrue after all work is completed, except "Final Cleanup" and seeding gravel pit and borrow areas and haul roads.

108.10 DEFAULT AND TERMINATION OF CONTRACT

- A. If for any cause whatsoever, the Contractor fails to carry on the work in an acceptable manner, the Contracting Agency will give notice in writing to the Contractor and the Contractor's surety of such delay, neglect, or default. The Contractor shall be considered in default and the contract may be terminated if any of the following shall occur:
1. Fails to begin the work under the contract within the time specified in the Notice to Proceed, or
 2. Fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of the work, or
 3. Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or
 4. Discontinues the prosecution of the work, or
 5. Fails to resume work which has been discontinued after notice to do so, or
 6. Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency, or
 7. Allows any final judgment to stand against the Contractor unsatisfied for a period of 5 days, or
 8. Makes an assignment for the benefit of creditors, or
 9. For any other cause whatsoever, fails to carry on the work in an acceptable manner, the Engineer will give notice in writing to the Contractor and the Contractor's surety of such delay, neglect, or default.
- B. If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Contracting Agency shall have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Contracting Agency may, at the Contracting Agency's option, call upon the surety to complete the work in accordance with the terms of the contract; or the Contracting Agency may take over the work, including any or all materials and equipment on the project as may be suitable and acceptable, and may complete the work by force account, or may enter into a new agreement for the completion of the contract according to the terms and provisions thereof, or use such other methods as, in the Contracting Agency's opinion, will be required for the completion of the contract in an acceptable manner.
- C. All costs and charges incurred by the Contracting Agency, together with the cost of completing the work under the contract, shall be deducted from any money due or which may become due the Contractor. In case the expense so incurred by the Contracting Agency shall be less than the sum which would have been payable under the contract if it had been completed by the Contractor, then the Contractor shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been

payable under the contract, then the Contractor and the Contractor's surety shall be liable and shall pay to the Contracting Agency the amount of said excess.

108.11 TERMINATION OF THE CONTRACTOR'S RESPONSIBILITY

- A. Whenever the improvement contemplated and covered by the contract shall have been completely performed on the part of the Contractor and all parts of the work have been approved and accepted by the Contracting Agency according to the contract, and the final estimate paid, the Contractor's obligations shall then be considered fulfilled, except as set forth in the Contractor's contract bond and as provided in Subsection [107.11](#), "Responsibility for Damage Claims."

108.12 RIGHT-OF-WAY DELAYS

- A. The Contractor may be compensated for delays caused solely by the failure of the Contracting Agency to furnish necessary rights-of-way, failure to deliver materials shown on the contract documents to be furnished by the Contracting Agency, or for the suspension of the work by the Contracting Agency for its own convenience or benefit. If the Contractor sustains loss which could not have been avoided by the judicious handling of forces, equipment, or plant, there shall be paid to the Contractor such amount as the Engineer may find to be fair and reasonable compensation for such part of the Contractor's actual loss as was unavoidable.
- B. If performance of the Contractor's work is delayed as the result of the failure of the Contracting Agency to acquire or clear right-of-way, an extension of time determined pursuant to the provisions of Subsection [108.08](#), "Determination and Extension of Contract Time," will be granted.

108.13 TERMINATION OF CONTRACT

- A. The Contracting Agency may, upon 30 days' written notice, terminate the contract or a portion thereof.
- B. When contracts, or any portion thereof, are terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits shall be considered.
- C. Reimbursement for organization of the work (when not otherwise included in the contract) and moving equipment to and from the job will be considered where the volume of work completed is too small to compensate the Contractor for these expenses under the contract unit prices, the intent being that an equitable settlement will be made with the Contractor.
- D. Acceptable materials, obtained by the Contractor for the work, that have been inspected, tested, and accepted by the Contracting Agency and that are not incorporated in the work may, at the option of the Engineer, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records, at such points of delivery as may be designated by the Contracting Agency.
- E. Termination of the contract or a portion thereof shall not relieve the Contractor's surety of its obligation for any just claims arising out of the work performed.

SECTION 109**MEASUREMENT AND PAYMENT****109.01 MEASUREMENT OF QUANTITIES**

- A. The measurements and determination of the number of units of each pay item will be made in general as prescribed hereinafter and specifically as set out under "Method of Measurement" and "Basis of Payment" in the specification of each pay item.
- B. After the items of work are completed and before final payment is made, the Engineer will determine the quantities of the various items of work performed as the basis for final settlement for all other than lump sum contracts. In the case of unit price items, the Contractor will be paid for the actual amount of work performed and materials used in accordance with these specifications, as shown by the final measurements, unless otherwise specified.
- C. Actual authorized quantities of work satisfactorily completed under the contract, shall be measured by the Engineer in accordance with United States Standard Measures, and well recognized engineering practices. Unauthorized wastings of material will be deducted and only such quantities as are actually incorporated in the completed work will be included in the final estimate. The planimeter shall be considered an instrument of precision adapted to the measurement of areas, but other acceptable methods may be used.
- D. Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computation will be the neat dimensions shown on the plans or ordered in writing by the Engineer.
- E. In computing volumes of excavation, embankment, and borrow, the average end area method will be used unless otherwise specified.
- F. All items that are measured by the linear foot such as pipe culverts, underdrains, guardrails, etc., shall be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans.
- G. Items may be measured by surface area, either square foot or square yard. The term "gage" when used in connection with the measurement of plates, shall mean the U.S. Standard Gage. When reference is made, however, to the measurements of galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, the term "gage" shall mean that specified in the respective test designation for the material as described in the "Materials" section of these specifications.
- H. When the term "gage" refers to the measurement of wire, it shall mean the wire gage specified in the AASHTO M 32 for cold drawn steel wire for concrete reinforcement.
- I. Unless otherwise specified, water meters shall be accurate to within 2 percent of the indicated amount. The frequency of checking water meters will be determined by the Engineer.
- J. The term ton shall mean the short ton consisting of 2,000 pounds avoirdupois. All materials that are specified for measurement by ton shall be weighed on accurate, approved scales set at locations designated by the Engineer. All materials shall be weighed on platform scales with the following exception: In lieu of platform scales, the

Contractor may provide an automatic printer system that will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching control system. Such a system shall issue a weigh ticket for each load. The Contractor shall have on hand not less than ten 50-pound standard weights for testing the scales.

K. Scales:

1. All scales shall be furnished by and at the expense of the Contractor and shall have a certificate of inspection by the Bureau of Weights and Measures. The scales shall be tested and inspected by the Bureau of Weights and Measures and a new inspection certificate required as often as the Engineer may deem necessary, and after each scale move, in order to ensure the accuracy of the scales. The cost of inspecting the scales shall be borne by the Contracting Agency.
2. Platform scales shall be of sufficient size and capacity to weigh, in one operation, the entire loaded vehicle. Combination vehicles may be weighed as separate units, provided the connecting device between vehicles is so constructed that no weight other than that of the device itself is transmitted to either vehicle. When combination vehicles are used, approaches to and from the scale platform shall be level for sufficient distance to accommodate that portion of the combination vehicle that is off the scale platform. In instances where combination vehicles are weighed, the approaches to and from the scale platform shall be level with the scale platform for a minimum distance of 50 feet from each end of the scale platform.
3. If combination vehicles are utilized, provisions shall be made to ensure that all braking devices are disengaged during weighing operations as insurance against stresses being transmitted between either vehicle.
4. The scale pit shall be of sufficient width to permit access to all scale components for purposes of inspection, repair, cleaning, and adjusting.
5. Support members for platform scales shall consist of 12-inch by 12-inch or 6-inch by 16-inch (minimum) timbers placed on a firm gravel foundation. Scales consisting of more than one section shall be supported with 12-inch by 12-inch or 6-inch by 16-inch (minimum) timbers at each end of each section to avoid settlement of the scale platform. Concrete support members conforming to the minimum timber size requirements may be utilized in lieu of timber at the Contractor's option.
6. Platform scales shall be equipped with weatherproof housing so constructed as to protect the recording device and permit the weighmaster convenient access to all beams and dials. The housing shall not be less than 6 feet wide, 8 feet long, and 7 feet high; shall have 2 windows, adjustable for ventilation with one facing the scales; and shall be equipped with an adequate shelf suitable to the Engineer. The Contractor shall provide heat and electric lights when requested by the Engineer.
7. Conveyor scales of an approved type may be used. The conveyor scales shall be furnished with 1 master counter to run continuously and 1 remote counter which will print the weight in individual loads, then reset to zero automatically. The remote unit shall be placed in a weatherproof house with 2 windows. One window shall face the point of loading and the conveyor scales. This window shall also be equipped with a shelf 2 feet wide and 6 feet long. A controlled method of heating shall be supplied for cold weather operations.
8. A locked door shall be provided on the access to the conveyor balances (where fine adjustment must be made). The key shall be in the hands of the Engineer and the

door shall be opened only for maintenance and adjustment of conveyor scales to meet the accuracy of the platform scales. This door shall be locked at all times during the operation of the conveyor scales. If conveyor weighing equipment is used, the following procedures shall be followed:

- a. The conveyor scales shall be calibrated against the platform scales, which shall have a certificate of inspection.
 - b. At the beginning and middle of each shift, or as requested by the Engineer, 2 consecutive loads of material weighed over the conveyor scales shall be reweighed on the platform scales. The total weight indicated by the conveyor scales on the 2 loads shall check with the platform scale weight within 0.5 percent. If the conveyor scales weigh out of this tolerance, all loads shall be weighed on the platform scales until the condition is rectified.
 - c. Consecutively numbered, individual weigh tickets shall be used with conveyor scale weights stamped by the remote counter.
- L. Unless otherwise specified, materials shipped by rail shall be weighed over the authorized project scales before incorporation into the work.
- M. Cement will be measured by the barrel or ton. The term "barrel" will mean 376 pounds of cement.
- N. Timber will be measured by the thousand feet board measure (Mfbm) actually incorporated in the structure with no allowance for any waste except beveled ends. Measurement will be based on nominal widths and thicknesses, and the extreme length of each piece.
- O. When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.
- P. All materials for which measurements are obtained by the cubic yard "loose measurement" or "measured in the vehicle" shall be hauled in approved vehicles and measured therein at the point of delivery. No allowance will be made for the settlement of material in transit. Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual delivered contents may be readily and accurately determined and will remain constant. Unless all approved vehicles on the work are of uniform capacity, each vehicle shall bear a plainly legible identification mark, indicating its specified approved capacity. All vehicles shall be loaded to at least waterlevel capacity. Loads not hauled in approved vehicles or of a quantity less than the specified approved quantity for the hauling vehicle will be subject to rejection and no compensation will be allowed for the hauling of the material.
- Q. Liquid Asphalts, Asphalt Cement, and Asphaltic Emulsions:
1. The unit of measurement for liquid asphalts, asphaltic emulsions, and paving asphalts shall be a ton or gallon at 60 degrees F.
 2. Quantities of bituminous binders wasted or disposed of in a manner not called for under these specifications, or remaining on hand after completion of the work, will not be paid for.
 3. When permitted by the Engineer, pay quantities of bituminous binder may be determined from volumetric measurements of the bituminous binder, in which case the bituminous binder shall be delivered in calibrated tanks and each tank shall be

accompanied by its proper measuring stick and a calibration card signed by a sealer of weight and measures, and pay quantities shall be determined in accordance with the following procedure.

4. Volumetric measurements at any temperature shall be reduced to the volume the material would occupy at 60 degrees F, before converting the volumetric measurements to weight.
5. The following tables shall be used to convert volumes from gallons to weight. All types, SC, MC, and RC of the same grade shall be considered to have equal weights and volume.

**AVERAGE WEIGHTS AND VOLUMES OF LIQUID ASPHALT
AT 60 DEGREES FAHRENHEIT**

Grade of Liquid Asphalt	Gallons Per Ton	Pounds Per Gallon
70	253	7.90
250	249	8.03
800	245	8.16
3000	241	8.30

**AVERAGE WEIGHTS AND VOLUMES OF ASPHALT CEMENT
AT 60 DEGREES FAHRENHEIT**

Grade	Gallon Per Ton	Pounds Per Gallon
AC-40	233	8.59
AC-30	235	8.51
AC-20	235	8.51
AC-10	237	8.43

**AVERAGE WEIGHTS AND VOLUMES OF ASPHALTIC EMULSION
AT 60 DEGREES FAHRENHEIT**

Type of Emulsion	Gallon Per Ton	Pounds Per Gallon
All Grades	240	8.33

6. When converting the volume of liquid asphalt, asphalt cement, or asphaltic emulsion at any temperature to the volume of 60 degrees F, a conversion factor for correlation shall be used. Said conversion factors shall be those prescribed in The Asphalt Institute (Pacific Coast Division) publication "Asphalts -- Paving Liquids and Emulsions" (PCD-7).
- R. Rental of equipment will be measured by time within 1/2 hour of actual working time and necessary traveling time of the equipment within the limits of the project. If equipment has been ordered on the job on a standby basis by the Engineer, half-time rates for the equipment will be paid.
- S. When equipment has been ordered by the Engineer in connection with force account work, travel time and transportation to the project will be measured as hereinafter outlined: For the use of equipment moved in on the work and used exclusively for extra work paid for on a force account basis, the Contractor will be paid the rental rates listed in the Special Provisions or determined as provided in Subsection [109.03](#), "Extra and Force

Account Work," and for the cost of transporting the equipment to the location of the work and its return to its original location, all in accordance with the following provisions:

1. The original location of the equipment to be hauled to the location of the work shall be agreed to by the Engineer in advance.
2. The Contracting Agency will pay the costs of loading and unloading such equipment.
3. The cost of transporting equipment in low bed trailers shall not exceed the hourly rates charged by established haulers.
4. The rental period shall begin at the time the equipment is unloaded at the site of the extra work, shall include each day that the equipment is at the site of extra work, excluding Saturdays, Sundays, and legal holidays unless the extra work is performed on such days, and shall terminate at the end of the day on which the Engineer directs the Contractor to discontinue the use of such equipment. The rental time to be paid per day will be in accordance with the following:

Hours Equipment Is In Operation	Hours To Be Paid
0	4
0.5	4.25
1	4.5
1.5	4.75
2	5
2.5	5.25
3	5.5
3.5	5.75
4	6
4.5	6.25
5	6.5
5.5	6.75
6	7
6.5	7.25
7	7.5
7.5	7.75
8	8
Over 8	Hours In Operation

- a. When hourly rates are listed, less than 30 minutes of operation shall be considered to be 1/2 hour of operation.
 - b. When daily rates are listed, payment for 1/2 day will be made if the equipment is not used. If the equipment is used, payment will be made for 1 day.
5. Should the Contractor desire the return of the equipment to a location other than its original location, the Contracting Agency will pay the cost of transportation in accordance with the above provisions, provided such payment shall not exceed the cost of moving the equipment to the work.

6. Payment for transporting and loading and unloading equipment as above provided will not be made if the equipment is used on the work in any other way than upon extra work paid for on a force account basis.
7. Material wasted or disposed of in a manner not called for under the contract, material not unloaded from the transporting vehicle, material placed outside of the limits indicated or given on the plans, or material remaining on hand after completion of the work will not be paid for except as otherwise provided.

109.02 SCOPE OF PAYMENT

- A. Unless otherwise provided under "Basis of Payment," payments to the Contractor will be made for the actual quantities of contract items performed in accordance with the plans and specifications, and if, upon completion of the construction, these actual quantities show either an increase or decrease from the quantities given in the bid schedule, the contract unit prices will still prevail, except as provided in Subsection [109.04](#), "Eliminated Items," and Subsection [104.02](#), "Increased or Decreased Quantities and Change in Character of Work." Except as provided in Subsection [107.16](#), "Contractor's Responsibility for the Work and Materials," the Contractor shall accept the compensation, as herein provided, in full payment for the following:
 1. The work complete, including all supervision, labor, material, tools, equipment, and incidentals necessary for all work contemplated and embraced under the contract;
 2. Any loss or damage to the nature of the work, the action of the elements, strikes or lockouts;
 3. Accidents to employees or the public, or both;
 4. Unforeseen difficulties or obstructions that may arise or be encountered during the prosecution of the work;
 5. All risks whatsoever connected with the work under contract until it is accepted by the Contracting Agency.
 6. All expenses incurred by or in consequence of, the suspension or discontinuance of the prosecution of the work as herein specified, and in completing the work and the whole thereof, including the carrying out of all the requirements of these "general requirements and covenants" in an acceptable manner according to the plans and specifications.
- B. If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule required the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item except as provided for in Subsection [104.05](#), "Rights in and Use of Materials Found on the Work."
- C. The payment of any partial estimate or of any retained percentage, except by and under the approved final estimate and voucher, in no way shall affect the obligation of the Contractor to repair or renew any defective parts of the construction or to be responsible for all damages due to such defects.
- D. In case of a lump sum contract, when required by the Special Provisions or requested by the Contracting Agency, the Contractor shall submit to the Contracting Agency within 15 days after award of contract, a detailed schedule in triplicate, to be used only as a basis for determining progress payments on a lump sum contract or any designated lump sum bid item. This schedule should equal in total the lump sum bid and shall be in such

form and sufficiently detailed as to satisfy the Contracting Agency that it correctly represents a reasonable apportionment of the lump sum.

109.03 EXTRA AND FORCE ACCOUNT WORK

- A. Extra work shall be paid for in accordance with the accepted contract change order. Work specified in the order to be performed at agreed unit prices shall be paid for in the same manner as proposal items.
- B. When extra work paid for on a force account basis is performed by forces other than the Contractor's organization, the Contractor shall reach agreement with such other forces as to the distribution of the payment by the Contracting Agency for such work.
- C. **Specialized Work:**
 - 1. Whenever the Contractor is required to perform originally unanticipated work of a specialized nature (electrical, plumbing, landscaping, etc.,) for which the Contractor is not properly equipped, the Contractor may upon approval of the Contracting Agency have the work performed by a local firm or specialist who is proficient in the type of work to be performed.
 - 2. Payment for this work shall be the Contractor's actual cost as evidenced by copies of invoices from the person or firm who performed the work. To the Contractor's actual cost shall be added the sum of 10 percent for the Contractor's profit and overhead with no further compensation therefor.
- D. **Owner-Operators:** Whenever the Contractor is authorized by the Contracting Agency to utilize bona fide owner-operators on Force Account work, payment shall be at the lump sum rate shown on the Contractor's payrolls which include wages and equipment rental. To this lump sum rate shall be added the sum of 10 percent for the Contractor's profit and overhead with no further compensation therefor.
- E. Work specified and performed on a force account basis should be paid for as follows:
 - 1. **Labor:**
 - a. Contractor will be paid the cost of labor for the workmen (including foremen when authorized by the Engineer), used in the actual and direct performance of the work. The cost of labor, whether the employer is the Contractor, subcontractor, or other forces, will be the sum of the following:
 - 1) **Actual Wages Plus Vacation Pay:** The actual wages paid, plus vacation pay, which shall not include any employer payments to, or on behalf of, workmen for health and welfare, pension, and similar purposes.
 - 2) **Labor Surcharge:** To the actual wages, plus vacation pay, as defined above, will be added a labor surcharge set forth in the Special Provisions, which labor surcharge shall constitute full compensation for all payments imposed by state and federal laws.
 - 3) **Fringe Benefits:** All other payments made to or on behalf of the workmen as required by collective bargaining agreements, or as otherwise provided in the Special Provisions.
 - 4) **Subsistence and Travel Allowance:** Subsistence and travel allowance paid to such workmen as required by collective bargaining agreements.

- b. To the total of the direct costs computed above, there will be added a markup of 20 percent.
 2. **Materials:** For materials accepted by the Engineer and used in the work, the Contractor shall receive the actual cost of such materials, to which cost shall be added an amount equal to 15 percent of the sum thereof.
 3. **Equipment:**
 - a. For any machinery or special equipment, the use of which has been authorized by the Engineer, the Contractor will be paid for the use of equipment at rental rates for such equipment which shall be determined as follows:
 - 1) The base rates shall be those established in publications and revisions thereto entitled *Rental Rate Blue Book for Construction Equipment*, Volumes 1-3, published by EquipmentWatch, a division of PRIMEDIA Business Magazines and Media, a PRIMEDIA company, which is a part of the contract.
 - 2) The hourly rate to be paid shall be the sum of the weekly Blue Book rate divided by 40 plus the estimated operating cost per hour shown therein.
 - 3) Attachments (e.g., tractor with ripper and dozer or tractor with loader and backhoe) will be included in the hourly rate only when deemed essential to the work as determined by the Engineer. When multiple attachments are approved for use and are being used interchangeably, the attachment having the higher rental rate shall be the only one included for payment.
 - 4) The total established rental rate per hour shall be rounded to the nearest 10 cents.
 - 5) Rental rates shall not be adjusted for regional differences.
 - 6) No compensation shall be allowed for shop tools having a daily rental rate of less than 10 dollars as set forth in Section 18 of the Rental Rate Blue Book.
 - b. If it is deemed necessary by the Engineer to use equipment not listed in the Rental Rate Blue Book, a suitable rental rate for such equipment will be established by the Engineer based on the rate of a comparable model or unit. The Contractor may furnish any cost data that might assist the Engineer in the establishment of such rental rate including an adequate description, trade or manufacturer's name, model, capacity, horsepower, years of manufacture, and purchase price.
 - c. Payment will be made for actual time, to which rental sum of 15 percent shall be added.
 - d. The rental rates paid as above provided shall include the cost of fuel, oil lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance and all incidentals, but not labor costs for the operation of the equipment.
 4. **Supervision and Tools:** No additional allowance shall be made for general superintendents, the use of small tools, or other costs for which no specified allowance is herein provided.

5. **Records:** At the end of each day the Contractor's representative and the Engineer shall compare records of the cost of the work to be done as ordered on a force account basis.
6. **Documentation:**
 - a. **Labor:** No payment will be made for labor performed on force account work until the Contractor shall furnish to the Contracting Agency certified copies of payrolls covering that period when the force account work was performed. The payrolls shall indicate name, classification, dates, daily hours, and hourly rate for each workman employed on the force account work.
 - b. **Materials:** Copies of the suppliers' invoices, including transportation charges, shall be furnished the Contracting Agency. However, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from the Contractor's stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor. The Contracting Agency may request additional documents to substantiate the Contractor's claims.

109.04 ELIMINATED ITEMS

- A. Should any items contained in the proposal be found unnecessary for the proper completion of the work, the Contracting Agency may, upon written order to the Contractor, eliminate such items from the contract, and such action shall in no way invalidate the contract. When the Contractor is notified of the elimination of items, the Contractor will be reimbursed for actual work done and all costs incurred, including mobilization of materials prior to said notification.

109.05 BLANK

109.06 PARTIAL PAYMENT

- A. The Engineer will, after award of contract, establish a monthly progress bill submittal date. Each month, the Contractor will make an approximate measurement of the work performed to that date, estimate its value based on the contract unit prices and/or approved schedule of values, and submit a progress bill on that date. The quantities and value estimates shall have the concurrence of the Engineer and the billing shall include supporting documentation such as material receipts and storage verifications. In accordance with NRS 338.525, the Engineer may withhold from a progress payment, with timely notice and a detailed explanation, a sufficient amount to compensate for failure(s) by the Contractor to comply with a contract requirement or applicable building code, law, or regulation.
- B. Monthly certified payroll records shall be submitted as required by NRS 338.070. If the record submittals scheduled for the previous month have not been received, the Contracting Agency may withhold funds in accordance with NRS 338.060 and NRS 338.515.
- C. From each progress bill submittal, 10 percent will be deducted and retained by the Contracting Agency, and the remainder less the amount of all previous payment(s) will be paid to the Contractor. After 50 percent of the work has been completed and if progress on the work is and remains satisfactory, the deduction to be made from the remaining

- progress billing submittals and from the final payment may be reduced or eliminated by the Contracting Agency.
- D. The Contracting Agency shall pay to the Contractor at the end of each quarter the interest earned on the amount retained under the contract during the quarter as provided in NRS 338.515.
 - E. The Contracting Agency's payment to the Contractor shall be made no later than 30 days after the receipt of an approved progress bill or retainage bill. Interest shall be paid on late payments as provided in NRS 338.530.
 - F. Partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the Contract, plans, and specifications, and are delivered to acceptable sites on the project or at other sites in the vicinity that are acceptable to the Engineer. Such delivered costs of stored or stockpiled material may be included in the next progress bill submittal after the following conditions are met:
 - 1. The material shall have been stored or stockpiled in a manner acceptable to the Engineer, at the project site or a site approved by the Engineer.
 - 2. The Contractor shall have furnished the Engineer with acceptable evidence of the quantity and quality of such stored or stockpiled materials.
 - 3. The Contractor shall have furnished the Contracting Agency legal title (free of liens or encumbrances of any kind) to the material so stored or stockpiled.
 - 4. The Contractor shall have furnished the Contracting Agency evidence that the material so stored or stockpiled is insured against loss, due to damage or to disappearance of such materials, at any time prior to use in the work.
 - G. Public Works Projects requiring a performance bond and a labor and material payment bond shall be exempt from the provisions of F.3 and F.4 immediately preceding. If materials are not specifically purchased for the work, but are taken from the Contractor's stock, then in lieu of invoices, there shall be submitted to the Engineer, statements accompanied by an affidavit of the Contractor, certifying such materials were taken from the Contractor's stock and the price and transportation claimed represent the actual cost to the Contractor.
 - H. It is understood and agreed that the transfer of title to, and the Contracting Agency's payment for such stored or stockpiled materials shall in no way relieve the Contractor of the Contractor's responsibility for furnishing and placing such materials in accordance with the requirements of the Contract, plans, and specifications.
 - I. In no case shall the amount of a progress billing submittal for material on hand exceed the Contract price for such material nor the Contract price for the Contract item in which the material is intended to be used.
 - J. The Contractor shall bear all costs associated with the progress payment of stored or stockpiled materials in accordance with the provisions of this subsection.

109.07 ACCEPTANCE AND FINAL PAYMENT

- A. When the final inspection and final acceptance have been duly made by the Engineer, as provided in Subsection [105.16](#), "Final Acceptance," and subject to the terms of Subsection [108.09](#), "Failure to Complete the Work on Time," the Contractor shall prepare the final estimate of the quantities of the various classes of work performed under the

contract. The Engineer shall examine such estimate and notify the Contractor in writing of the Engineer's agreement or disagreement, including any amounts to be withheld in accordance with NRS 338.525.

- B. Final acceptance of the work by the Contracting Agency shall be withheld until the Contractor furnishes all certificates, guaranties, releases, certified payroll records, affidavits, etc., required by these specifications or the Special Provisions.
- C. The acceptance by the Contractor of final payment shall be and shall operate as a release to the Contracting Agency of all claims and all liability by the Contractor for all things done or furnished in connection with this work and for every act and neglect of the Contracting Agency and others relating to or arising out of this work. No payment, however, final or otherwise shall operate to release the Contractor or the Contractor's sureties from any obligations under this contract or the performance and labor and material payment bond.

109.08 BLANK

SECTION 204

ROUNDED AND TRANSITION SLOPES

DESCRIPTION

204.01.01 GENERAL

- A. This work shall consist of rounding and shaping slopes in accordance with the plans and where designated by the Engineer.

MATERIALS

204.02.01 BLANK

CONSTRUCTION

204.03.01 GENERAL

- A. The top of cut slopes shall be rounded by excavating to blend the cut slopes with the adjacent natural terrain. At the intersections of cuts and fills, slopes shall be adjusted and warped to blend into each other or into the natural ground surface without noticeable break.
- B. Slopes will be staked for flattening and rounding in places where the material is other than solid rock. Rock formations such as shales, decomposed sandstone, and granite that can be readily excavated by means of hand tools, shall have the slopes flattened and rounded the same as the earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes. Where the depth of cut is insufficient to provide the full rounding required, the distance for rounding shall be proportionately adjusted.
- C. Slopes rounding and warping shall also apply to all drainage ditches when such rounding will improve the appearance of the roadside.
- D. Whenever the treatment of the slopes may destroy or injure standing timber, trees, or other vegetation which should be preserved, adjustments in slope grading will be made. These adjustments shall be effected by a gradual transition from the theoretical grading section required.
- E. The degree of smoothness required in rounding and warping slopes shall be as specified in Subsection [203.03.07](#), "Slopes."

METHOD OF MEASUREMENT

204.04.01 MEASUREMENT

- A. The quantity of rounded cut slopes to be paid for shall be measured in linear feet of slopes, treated as specified, measured along the roadway ditch each side of the roadway centerline. The quantity of rounded embankment slopes to be paid for shall be measured in linear feet, treated as specified, measured along the centerline of the embankment to be rounded, and each side shall be considered separately. In all cases, each 100 feet shall constitute the unit of one station. Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.
- B. All measurements will be made in accordance with Subsection [109.01](#), "Measurement of Quantities."

BASIS OF PAYMENT

204.05.01 PAYMENT

- A. The accepted quantity of slope rounding measured as specified in Subsection [204.04.01](#), "Measurement," will be paid for at the contract unit price bid per station of the completed work.
- B. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."
- C. Payment will be made under:

PAY ITEM**PAY UNIT**

Slope Rounding Stations

SECTION 208**TRENCH EXCAVATION AND BACKFILL****DESCRIPTION****208.01.01 GENERAL**

- A. This work shall consist of the excavation and backfill of trenches for the accommodation of substructures including, but not limited to electrical conduits, telephone conduits, television cable, traffic signal conduits, gas lines, sewer lines, water lines, and storm drains except where governed by utility agency specifications. These other agencies are responsible for the trench to the top of subgrade (bottom of the pavement section).
- B. When the terms "Backfill" or "Trench Backfill" are used herein, they shall be construed to mean one or more of the types of backfill specified below under "Materials."
- C. The designing engineer shall comply with the intent of the pipe material as defined as either rigid or flexible in conformance with the AASHTO LRFD Bridge Design and Construction Specifications and this Section. Special attention shall be given to the sidewall material properties as this section assumes a minimum AASHTO A1 or A3 material. Other sidewall material type shall be given special consideration for minimum trench widths, the use of Controlled Low Strength Materials (CLSM), or other critical processes that would affect the pipe ability to withstand the load and shall also be noted on the plans and specifications for the project.
- D. The type of pipe and applicable installation requirement (trench and embankment) to be used as demonstrated by the design and approved by the Agency Engineer shall be clearly noted on the drawings and specifications along with installation procedures that may differ from this section.
- E. Quality control field inspection and testing requirements including frequency shall be in accordance with Contracting Agency requirements.

208.01.02 DEFINITIONS

- A. **Foundation:** Over-excavation and backfill of the foundation is required only when the native trench bottom does not provide a firm-working platform for placement of the pipe bedding material.
- B. **Bedding:** In addition to bringing the trench bottom to required grade, the bedding levels out any irregularities and ensures uniform support along the length of the pipe.
- C. **Haunch Zone:** The backfill under the lower half of the pipe (haunches) distributes the superimposed loadings.
- D. **Initial Zone:** The backfill from the springline to the top of the pipe zone provides the primary support against lateral pipe deformation for flexible pipe.
- E. **Final Zone:** Backfill above the pipe zone to the top of subgrade.

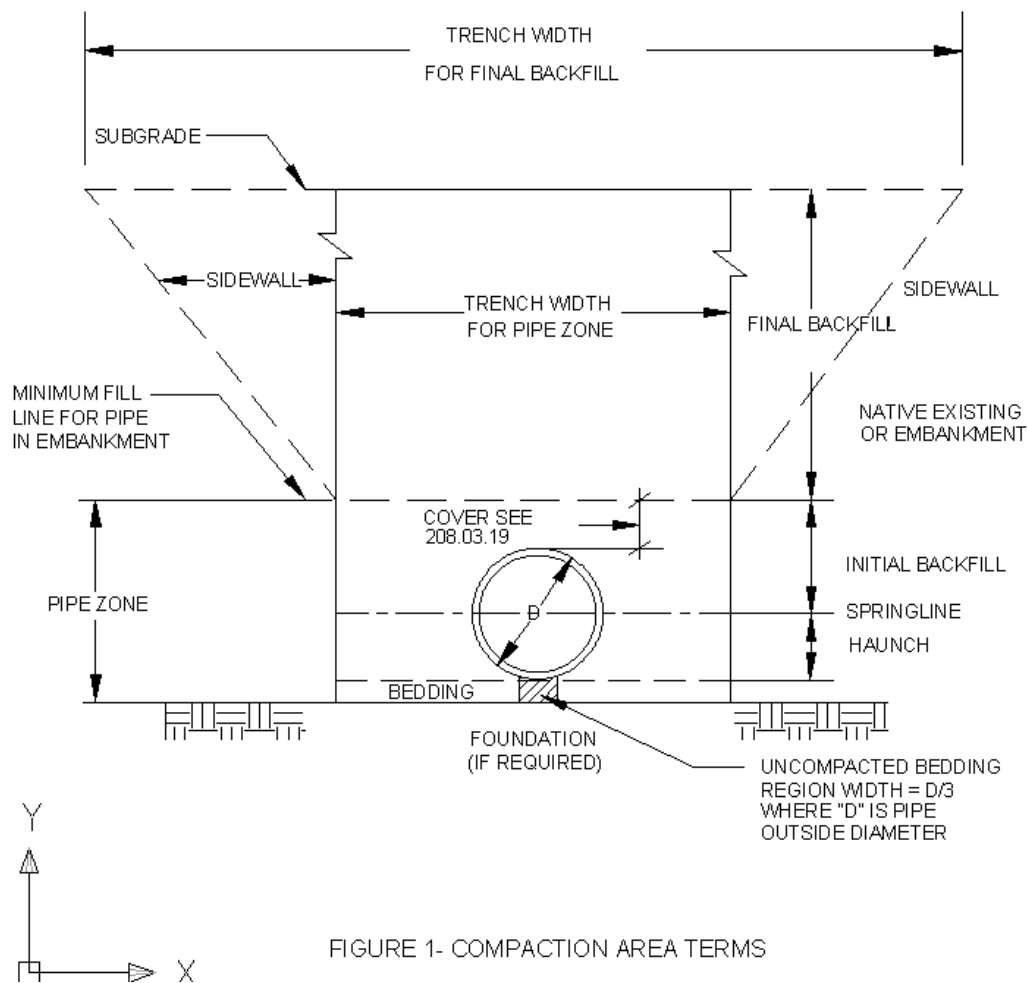


FIGURE 1- COMPACTION AREA TERMS

MATERIALS

208.02.01 GENERAL

- A. The material placement in the pipe zone area shall first comply with Table 1, when applicable.

Table 1 - Pipe Zone Maximum Particle Size for Backfill

Nominal Pipe Size (inches)	Maximum Particle Size (inches)
2 to 4	1/2
6 to 8	3/4
10 to 16	1
18 and larger	1-1/2

- B. One of two methods of compaction of the trench pipe zone shall be used and shall be specified in the Construction Documents and approved by the Engineer prior to construction:
- Method A:** The use of CLSM as defined in this section.

2. **Method B:** The use of aggregate materials as described in this section as associated with either Rigid or Flexible designed pipe shall be as specified in this subsection below.
- C. Prior to construction, the materials and method type shall be submitted and approved by the Engineer.

208.02.02 SELECTED BACKFILL

- A. This material shall be similar to that removed from the trench excavation or may be imported material as specified in Subsection [207.02.01](#), "Selected Backfill," or as otherwise shown on the Drawings.

208.02.03 GRANULAR BACKFILL

- A. Granular backfill shall be as specified in Subsection [207.02.02](#), "Granular Backfill."

208.02.04 SAND BACKFILL (DRY UTILITIES ONLY)

- A. Sand backfill shall consist of natural sand or a mixture of sand with gravel or stone. In addition thereto, the material shall conform to the following gradation requirements:

Table 2 - Sand Backfill Gradation

Sieve Sizes	Percentage of Weight Passing
3/8 inch	100
No. 4	80-100
No. 200	5-20

- B. The plasticity index of the material shall be as specified in Subsection [704.03.01](#), "Plastic Limits." The soluble sulfate content shall not exceed 0.3 percent by dry weight of soil.

208.02.05 TYPE II AGGREGATE BASE BACKFILL

- A. Type II aggregate base backfill shall be as specified in Subsection [704.03.04](#), "Type II Aggregate Base." The total available water soluble sulfate content shall not exceed 0.3 percent by dry weight of soil.

208.02.06 DRAIN BACKFILL

- A. Drain backfill shall be as specified in Subsection [704.03.02](#), "Drain Backfill." The type shall be as shown on the plans or approved by the Engineer.

208.02.07 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Backfill shall be as specified in Subsection [704.03.07](#), "Controlled Low Strength Material."

208.02.08 CRUSHED ROCK

- A. The materials properties shall conform to Subsection [704.03.06](#), "Crushed Rock."

208.02.09 TYPE III AGGREGATE

- A. Aggregate properties and gradation shall conform to Type III as specified in Subsection [704.03.05](#), "Type III Aggregate," or as approved by the Engineer.

CONSTRUCTION

208.03.01 TRENCH EXCAVATION, GENERAL

- A. Excavation including the manner of supporting excavation and provisions for access to trenches, shall comply with the current regulations as determined by NOSHA. Excavation shall include, without classifications, the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the work. The removal of said materials shall conform to the lines and grade shown. Excavation for pipe, wire, or conduits shall be by open trench unless otherwise specified or shown on the plans. However, should the Contractor elect to tunnel or jack any portion not so specified, he shall first submit a design by a Nevada Professional Engineer to and obtain an approval from the Engineer. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavation, and all pumping, ditching, or other approved measures for the removal or exclusion of water, including storm water and wastewater reaching the site of the work from any source so as to prevent damage to the work or adjoining property. The Contractor shall be responsible for any damage to persons or property due to interruption or diversion of storm or wastewater because of his operations. If due to delays in delivery of materials or for other reasons, and the Contractor is not expected to fully complete the work within any excavated area in a reasonable length of time as determined by the Engineer, the Engineer may require the Contractor to backfill the excavation and re-excavate when the work can be completed expeditiously, with no additional payment therefor.
- B. Except as otherwise shown or provided herein, excavation shall be open cut trenches with vertical sides up to the top of the pipe zone.

208.03.02 MINIMUM TRENCH WIDTH

- A. Excavation of pipe trench for flexible and rigid pipe is as required in Table 3 and this width is only applicable for trenches that have trench sidewall of native material" which meets the classification class A1 or A3 installation as defined in AASHTO M145 table. In all cases, the trench width shall be wide enough to allow for the compaction equipment.

Table 3 - Minimum Trench Widths

Flexible Pipe	Minimum shall be not less than 1.5 times the pipe outside diameter plus 12 inches
Rigid Pipe	Minimum shall be not less than the outside diameter plus the outside diameter times 0.33

- B. For pipe backfill using CLSM, the minimum trench width may be reduced to the pipe diameter plus 12 inches and enough room needed to allow for the proper placement of the CLSM using tools to "spade" the material under the pipe haunches. This condition applies only for trench sidewalls meeting the minimum AASHTO material class A1 or A3.
- C. If the sidewall trench soil is classified other than AASHTO Class A1 or A3, a recommendation by a Nevada Professional Engineer shall be submitted and approved by the Engineer prior to construction. However, minimum trench width shall not be less than the minimum stated in this section.

208.03.03 MAXIMUM TRENCH WIDTH

- A. The maximum width of the trench shall be determined by the Contractor based on the method and means for the installation. However, trench width shall not exceed the width of a ride-along compactor plus 2 feet when working along side the pipe or culvert. If for

- any reason this maximum trench width is exceeded, a higher strength of pipe may be required as determined by the Engineer with no additional cost to the Contracting Agency.
- B. Except when otherwise specified or ordered by the Engineer, the bottom of the trench shall be excavated uniformly to the grade or depth indicated on the drawings. The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater, unless otherwise approved by the Engineer. Trench shall be considered open until backfilled to the top of subgrade. Trenches crossing streets shall be completely backfilled immediately after pipe, wire, or conduit installation.
 - C. Substantial bridging, properly anchored, capable of carrying the design loading, in addition to adequate trench bracing, shall be used to bridge across trenches at street crossings where trench backfill and temporary patches have not been completed during regular working hours. Safe and convenient passage for pedestrians and access to all properties shall be provided.

208.03.04 TRENCH OVER-EXCAVATION

- A. Wherever the excavation is made below the grade shown on the drawings, or below the grade ordered by the Engineer, it shall be refilled to the required grade with suitable backfill and bedding material ""at no additional cost to the Contracting Agency.
- B. Trench over-excavation below the specified level of bedding material, and additional backfill material, ordered by the Engineer where unsuitable materials are encountered, shall be paid by the appropriate contract item.
- C. Trench over-excavation and backfill to control groundwater shall be at the option and expense of the Contractor; however, the backfill material shall comply with this specification and the approved design of the pipe.

208.03.05 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIALS

- A. Excess material and excavated material unsuitable for backfill shall be removed from the site of the work by the end of each working day unless otherwise approved by the Engineer and disposed of by the Contractor as specified in Subsection [107.14](#), "Disposal of Material Outside Project Right-of-Way."

208.03.06 CHANGES IN ALIGNMENT OR GRADE

- A. In the event that changes in elevation of the trench of less than 6 inches are ordered by the Engineer, no changes in the contract amount will be allowed. When such changes in elevation are more than 6 inches or changes in alignment are made that change the character of the work required, the work shall be performed as specified in Subsection [104.02](#), "Increased or Decreased Quantities and Change in Character of Work."

208.03.07 PORTABLE TRENCH SHIELD

- A. Portable trench shields or boxes that provide a moveable safe working area for installing pipe may be used for the installation of pipe. After placing the pipe in the trench, backfill material shall be placed in lifts and the shield shall be lifted to allow for the backfill material to be placed for each lift, trench wall to trench wall.

208.03.08 MINIMUM PIPE SPACING

- A. If the pipe space between parallel pipes in a single trench is not conducive to mechanical backfill, then CLSM shall be used.

208.03.09 TRENCH BACKFILL

- A. The backfilling of the trench differs in each zone due to the complexity of providing a secure support for the pipe as well as ensuring that all voids are filled to prevent nuisance water flow under the pipe. The zones are foundation, bedding, haunch, initial, and final as illustrated in Figure 1.

208.03.10 USE OF CLSM

- A. CLSM may be placed in all installations. However, for flexible pipe, in the pipe zone region, either full CLSM or full aggregate backfill is required. There can not be applied a mixing of CLSM and aggregate fill layers due to the different stresses that can occur on the pipe at the interface of both types of products.
- B. CLSM shall be placed directly into the space to be filled. The placement of CLSM shall include "spading" under the pipe haunches and into the corrugations or other difficult areas around a structure. Care shall be taken to prevent flotation or misalignment of the pipe by means of straps, soil anchors or other designed and approved means of restraint as per the manufacturer's recommendation. Material may be placed in stages equally on both sides of the pipe to prevent movement or flotation of pipe.
- C. If Bonded Aggregate Fill (BAF) is to be used, it shall be as specified in Subsection [704.03.07](#), "Controlled Low Strength Material (CLSM)."

208.03.11 FOUNDATION

- A. Trench foundation shall be stable prior to placing bedding material. If the Engineer determines that unsuitable materials exist at the trench foundation, the Contractor shall remove and replace the material as directed by the Engineer and as specified in Subsection [208.03.04](#), "Trench Over-Excavation."

208.03.12 PIPE BEDDING

- A. **Dry Utilities:** Dry utilities shall be defined as facilities for fiber optics, electrical, telephone, television cable, traffic signals, and natural gas lines. Pipe bedding for dry utilities only may consist of sand in compliance with applicable utility agency's specifications. In all cases, when sand is used as a bedding material, the sand shall be moisture conditioned and mechanically compacted.
- B. **Wet Utilities:** Wet utilities shall be defined as facilities for sewer lines, water lines, and storm drains. Except as otherwise provided herein, or in the Special Provisions, or as otherwise shown on the plans, the trench shall be excavated to a depth of at least 4 inches to 6 inches below the bottom of the pipe barrel and to a depth that will be sufficient to provide at least 2 inches of clearance under the pipe bell (where applicable).
- C. Uniform and stable bedding shall be provided for the pipe and any protruding features of its joints and/or fittings with the exception that the middle of the bedding equal to 1/3 the pipe outside diameter shall be loosely placed (see Figure 1). The compaction shall be:
 - 1. Compaction density minimum = 90 percent of the maximum density as determined by test method AASHTO T180 with exception of the middle uncompacted area.

- D. The material for use as bedding shall be Type II/III Aggregate Base or CLSM complying with this section. Crushed Rock may be used to stabilize the trench foundation and shall be specifically approved by the governing agency.
- E. Bedding shall be backfilled to the required grade of the bottom of the pipe. When Crushed Rock is used for foundation stabilization, the Contractor shall follow the same procedures described below in Subsection [208.03.16](#), "Drain Backfill."
- F. All pipes shall be placed directly on the bedding material unless otherwise required or approved by the Engineer. If groundwater is present or anticipated to be present, the need for a filter material as specified in Subsection [207.03.01](#), "General," shall be reviewed and approval may be required by the Engineer.

208.03.13 HAUNCH ZONE BACKFILL

- A. **Dry Utilities:** After pipe or conduit is laid, the haunch areas shall be backfilled with sand in compliance with applicable utility agency's specifications. In all cases, when sand is used as a backfill material, the sand shall be moisture conditioned and mechanically compacted.
- B. **Wet Utilities:** After the pipe or conduit is laid, the haunch areas shall be backfilled with Type II, Type III, Aggregate Base Backfill, or CLSM. Crushed Rock or drain backfill may be used for the haunch zone only if material use has been specifically approved by the governing agency. If crushed rock or drain backfill is used, comply with Subsection [208.03.16](#), "Drain Backfill."
- C. Compaction of the haunching material can best be accomplished by hand with tampers or suitable power compactors for maximum compacted lift thickness of 6 inches. The Contractor shall take care to not disturb the pipe from its line and grade and shall compact to:
 - 1. Compaction minimum = 90 percent of the maximum density as determined by test method AASHTO T180.
- D. While compacting the embedment near the pipe with impact-type tampers, caution shall be taken to not allow direct contact of the equipment with the pipe.

208.03.14 INITIAL ZONE BACKFILL

- A. **Dry Utilities:** Initial zone backfill for dry utilities may consist of sand in compliance with applicable utility agency's specifications. In all cases, when sand is used as a backfill material, the sand shall be moisture conditioned and mechanically compacted.
- B. **Wet Utilities:** After the pipe or conduit is laid, the initial backfill areas shall use Type II, Type III, Aggregate Base, or CLSM. Avoid usage of impact tampers directly above the pipe until the full loose layer backfill depth above the pipe is obtained. Crushed Rock or drain backfill may be used for the initial zone only if material use has been specifically approved by the governing agency. If crushed rock or drain backfill is used, comply with Subsection [208.03.16](#), "Drain Backfill." The depth of initial backfill above the pipe shall comply with Table 4:

Table 4 - Initial Zone Material Depths

Pipe or Conduit	Initial Zone
2-inch or less diameter	6 inches above the top of pipe
Greater than 2-inch diameter	12 inches above top of the pipe

208.03.15 FINAL ZONE BACKFILL

- A. The remaining backfill shall consist of one of the following types as determined by the Engineer.
- B. Granular, Selected, or CLSM Backfill. Backfill material from the initial backfill zone to a plane, which is below the bottom of the pavement section, shall be "Granular Backfill," "Selected Backfill," or CLSM.
 - 1. The material shall be compacted to:
 - a. Compaction minimum = 90 percent of the maximum density as determined by test method AASHTO T180.
 - b. If "Selected Backfill" is used in trenches 2 feet or less in width, no stones or lumps greater than 3 inches will be permitted.
 - 2. **CLSM:** When used, CLSM backfill shall be placed from the top of the initial backfill zone to the bottom of the bituminous pavement (top of aggregate base).
- C. CLSM Cap: Unless otherwise specified by the Contracting Agency, a CLSM Cap shall be required in the upper portion of the Final Zone for all non-residential roadways with a minimum thickness of 12 inches for all minor collectors and 24 inches for all major collectors and arterials.

208.03.16 DRAIN BACKFILL

- A. In the event that Drain Backfill is used to control groundwater, the Contractor shall, at no additional cost to the Contracting Agency, construct dams conforming to the requirements of Section [501](#), "Portland Cement Concrete," Class II CLSM, or compacted Type II Aggregate Base. Construct the dams within the drain rock bedding material at each manhole or at intervals of 600 feet, whichever is less. Dams shall extend the width of the trench, a minimum of 18 inches in length, for the height of the drain backfill, and where Type II is used, the compaction shall be:
 - 1. Compaction minimum = 95 percent of the maximum density as determined by test method AASHTO T180.
- B. The Contractor shall install nonwoven geotextile filter fabric between the bedding and backfill material in such a manner to prevent migration of the backfill material into the bedding whenever Drain Rock or Crushed Rock is used as bedding.
- C. Geotextile filter fabric shall conform to the requirements specified in AASHTO M288, "Subsurface Drainage Geotextile."

208.03.17 COMPACTION

- A. Compaction shall be performed by mechanical means. Mechanically compacted backfill shall be placed in layers of thickness compatible with the characteristics of the backfill and the type of equipment being used and shall have a maximum lift thickness as indicated in Table 5 - Compaction Lift Thickness. The lifts shall be placed on both sides of the pipe at the same time to reduce pipe movement.

Table 5 - Compaction Lift Thickness

Location	Maximum Compacted Lift Thickness (inches)	Maximum Loose Lift Thickness (inches)
Bedding, Haunch, and Initial Zones	6	8
Final Zone Backfill	12	16

- B. Each layer shall be evenly spread, moistened, and tamped or rolled until the specified relative compaction has been attained.
- C. Compaction minimum = 90 percent of the maximum density as determined by test method AASHTO T180.

208.03.18 TRANSITION INSTALLATIONS

- A. When differential conditions of pipe support might occur, such as in transitions from manholes to trench, a transition support region shall be provided to ensure uniform pipe support and preclude the development of shear, or other concentrated loading on the pipe.

208.03.19 MINIMUM DEPTH OF COVER

- A. The minimum cover shall be as stated on the plans and/or contract Special Provisions. For flexible pipe, the minimum cover for compaction process using wheel or hydro hammer loads is 24 inches. Equipment used for the initial zone shall allow compaction to the lift requirements of this specification without damage to the pipe.

208.03.20 TESTING

- A. Where tests reveal non-compliance with the requirements of the Contract, the Contractor shall bear the costs of subsequent rework and retesting until the required specification compliance is obtained to the satisfaction of the Engineer.

208.03.21 CUTTING AND RESTORING STREET SURFACING

- A. Prior to beginning work within any public right-of-way, or cutting any street surfacing therein, an encroachment permit and barricade plan approval shall be obtained from the governmental entity or agency having jurisdiction over that right-of-way.
- B. Permit fees and construction restrictions shall be in accordance with the rules, regulations, and ordinances of the entity or agency having jurisdiction.
- C. While undergoing improvements, all streets upon or within which any work is being done shall be kept open to all traffic by the Contractor, as specified in Subsection [104.04](#), "Maintenance of Traffic," unless otherwise approved by the Engineer, or as provided in the Special Provisions.
- D. Prior to beginning the work, barricading and traffic control devices conforming to the latest editions of the Traffic Control Plans for Highway Work Zones for the Clark County Area and the *Manual on Uniform Traffic Control Devices* shall be in place, and shall be in compliance with the governmental agency approved traffic control and barricade plan.
- E. Pavement in the area of the trench excavation may be wheel cut or spade cut.
- F. Temporary Steel Plate Bridging: When approved by the Engineer or Contracting Agency, the Contractor may use steel plates to bridge excavated trenches in areas where the

roadway surface is to be opened to traffic. Steel plates shall have non-skid surfaces and shall extend at least 12 inches beyond the edges of the trench. Trenches shall be adequately reinforced to support the bridging and traffic loads. Trench plate thickness shall be at least 3/4 inches for a 1 foot wide trench and shall increase 1/8 inch for every foot of trench width up to a thickness of 1-1/4 inch for a 5 foot wide trench. Steel plates for trench widths greater than 5 feet shall require a special structural design. The placement and installation method for temporary steel plate bridging shall be as follows:

1. Method 1: Roadways with posted speeds of 45 mph and greater – The pavement shall be cold-planed to a depth equal to the thickness of the plate and to a width and length equal to the dimensions of the plate(s). The approach and ending plates shall be attached to the roadway by a minimum of 2 dowels pre-drilled into the corners of the plate and drilled 2 inches into the pavement, subsequent plates shall be butted to each other.
 2. Method 2: Roadways with posted speeds less than 45 mph – Approach and ending plates shall be attached to the roadway by a minimum of 2 dowels pre-drilled into the corners of the plate and drilled 2 inches into the pavement. Subsequent plates shall be butted to each other. Fine graded asphalt concrete shall be compacted to form ramps with a maximum slope of 8.5% and a minimum 12 inch taper to cover all edges of the steel plates. When steel plates are removed, the dowel holes in the pavement shall be backfilled with either graded fines of asphalt concrete mix, concrete slurry, or an equivalent slurry approved by the Engineer.
- G. Whenever permanent pavement patches are not constructed immediately following trench backfilling operations, temporary pavement patches consisting of a minimum of 2 inches of hot or cold plantmix or plates shall be utilized to provide the required number of paved travel lanes. Plates may be left in place for a maximum of 14 days or unless otherwise approved by the Engineer. Temporary pavement patches may be left in place for a maximum of 30 working days following completion of backfilling operations unless otherwise approved by the Engineer.
- H. The following surface tolerance for temporary patches shall be observed. When a 12-foot straight edge is laid across the temporary patch parallel to the centerline of the street and in a direction transverse to the centerline, a rut, hump, or depression of more than 1/2 inch shall not be evident. Deteriorated temporary patches exhibiting ruts, humps, or depressions shall be repaired or replaced immediately upon notification of the Engineer. If the existing street exceeds the above tolerances, then the temporary patch shall be equal to or better than the condition of the surrounding pavements.
- I. Unless otherwise specified and approved, prior to placing the permanent patch, the existing pavement shall be saw cut to a neat line and to a minimum width as shown on the Standard Drawings for Pavement Restoration.
- J. Existing aggregate base, shall be scarified and recompacted to meet the requirements of Section [302](#), "Aggregate Base Courses." Compaction by rolling with vehicle tires will not be permitted. Aggregate base courses that were constructed with geosynthetics shall be repaired in conformance with the manufacturer's recommendations.
- K. Existing asphalt concrete shall be replaced with the same depth on major streets (greater than 60 feet of planned right-of-way) except that the minimum depth shall be 4) inches and shall be placed in multiple lifts of equal thickness. Existing asphalt concrete shall be replaced with the same depth in local streets (60 feet or less of planned right-of-way) except that the minimum depth shall be 3 inches; for existing depth of 4 inches or more, pavement shall be replaced in multiple lifts of equal thickness within the parameters

established in Section [401](#), "Plantmix Bituminous Pavements - General." The pavement material shall be similar to the original. If not known, request from the Engineer the current mix type used on Contracting Agency Capital Improvement Projects (CIP).

- L. Completion of the permanent patch in areas where an open graded surface course exists, which is less than 10 years in age, shall include placement of a surface course to match the existing surface texture and material mix design, including original bituminous cement type.
- M. In areas where lime treated sub-base, cement modified sub-base, soil cement, or similar materials have been used, the Contractor may substitute a lean concrete mix or asphalt concrete equivalent, subject to approval of the Engineer.
- N. Upon completion of the permanent patch, including the surface treatment, the surface shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. The Contractor shall inspect with a straightedge 12 feet long that is laid across the permanent patch parallel to the centerline of the street and in a direction transverse to the centerline. The surface shall not vary more than 1/4 inch from the lower edge of the straightedge. Patches exhibiting deviations greater than 1/4) inch shall be replaced or use mechanical grinding prior to acceptance of the patch. If the existing street exceeds the above tolerances, then the patch shall be equal to or better than the condition of the surrounding pavement. The Contractor shall submit a report of the tolerance testing to the Engineer for approval prior to the acceptance of the patch.
- O. Any concrete improvements disturbed or damaged during construction shall be replaced prior to placement of the permanent pavement patch.
- P. All traffic control devices removed or disturbed during construction shall be replaced upon completion of the permanent patch including but not limited to delineation, paint, thermoplastic pavement markings, and traffic signal detector loops. Temporary lane lines and other markings used during construction shall be permanently removed, to the satisfaction of the Engineer, prior to placing the new traffic stripes or markings.

METHOD OF MEASUREMENT

208.04.01 MEASUREMENT

- A. Unless otherwise provided in the Special Provisions, trench excavation and backfill will not be measured for payment.
- B. The quantity of Permanent Patch to be measured for payment will be the number of square yards complete, in place, and conforming to all requirements herein.

BASIS OF PAYMENT

208.05.01 PAYMENT

- A. Unless otherwise provided in the Special Provisions, no payment will be made for trench excavation or backfill as such; the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant.
- B. No payment will be made for temporary cold plantmix patching as such; the cost thereof is considered as included in the price bid for the construction or installation of the items to which such patching is incidental or appurtenant.

- C. The contract unit price paid for Permanent Patch as measured in Subsection [208.04.01](#), "Measurement," shall be full compensation for saw cutting, removal of asphalt, Type II aggregate base, prime coat, tack coat, and seal coat if required, asphaltic pavement (excluding open-grade or gap-grade UTACS), pavement markings, compaction, and for all labor, tools, equipment and incidentals necessary to complete the work as specified herein, as shown on the plans, and as directed by the Engineer. Compensation for trenching, backfilling, and compaction of pipe zone and other items of work, which are considered as part of underground piping or conduit work, shall be included with the contract bid item for such piping or conduit work.
- D. Payment for such excavation or backfill will be made only when the Special Provisions provide.
- E. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."
- F. Payment will be made under:

PAY ITEM**PAY UNIT**

Permanent PatchSquare Yard

SECTION 212

LANDSCAPING

DESCRIPTION

212.01.01 GENERAL

- A. This work shall consist of furnishing and planting trees, shrubs, and ground covers where shown on the plans or as established by the Engineer, all in accordance with specifications and accepted horticultural practices.

MATERIALS

212.02.01 GENERAL

- A. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section [726](#), "Roadside Materials."

212.02.02 NOMENCLATURE

- A. Nomenclature for plant names and varieties shall be in accordance with the latest edition of "Standardized Plant Names" as prepared by the American Joint Committee on Horticultural Nomenclature.
- B. All plant material in these specifications will be classified by group as follows:
1. Plants, Group A: Denotes container plant material
 2. Plants, Group B: Denotes balled and burlapped plant material
 3. Plants, Group C: Denotes ground cover
 4. Plants, Group D: Denotes grass (turf)

212.02.03 QUALITY OF PLANT MATERIALS

- A. It is the intent that all plant materials meet the standards as set forth herein, throughout the life of the contract. During inspections, as set forth hereinafter, all plant material will be judged and rejections shall be based upon these standards.
- B. All plants shall conform to the applicable requirements as specified in Subsection [726.03.06](#), "Plants."
- C. In determining the quality of plant material, the following elements shall be evaluated:
1. Root condition.
 2. Plant size (above ground).
 3. Insect and disease free condition.
 4. General appearance (color, shape, prior pruning).
- D. All container grown plants specified in the plans shall be established in the container in which the plants are sold, and grown in that container sufficiently long for the new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

- E. Balled and burlapped plants shall be plants dug with the ball of earth in which the plants are growing. Ball sizes shall be of the diameter and depth specified in the plans and contain enough fibrous root system for the full recovery of the plant. Balled plants shall have the ball firm and unbroken.
- F. Pruning of plants shall not be done prior to delivery to the planting site except by approval of the Engineer. Plant pruning when found necessary to remove damaged branches and to improve the plant shape and form when approved by the Engineer shall be accomplished after completion of individual planting operations.
- G. A deficiency in any one or more of these areas shall be sufficient reason to reject selectively or by lot.
- H. Grass or legume seeds shall conform to the requirements of Subsection [211.02.03](#), "Seed."

212.02.04 HANDLING AND SHIPPING

- A. Plants shall be packed for shipment according to standard practice for the type of plant being shipped. The root system of plants shall not be permitted to dry out at any time. Plants shall be protected against heat and freezing temperatures, sun, wind, climatic, or seasonal conditions during transit. Plant material shall be furnished in containers unless otherwise specified. Plants specified balled and burlapped (B & B) shall be handled by the ball of earth and not the plant. Broken or "made" balls will not be acceptable. Container grown plants shall be well developed with sufficient root development to hold the earth intact after removal from the container without being root bound.

212.02.05 INSPECTION OF PLANT MATERIAL

- A. The Contractor shall inform the Engineer as soon as possible of the source of plant material for the project. At the Engineer's option an inspection of all plant materials at the source may be required prior to shipping of plants from the nursery. This inspection shall coordinate the judgment areas regarding size and quality of plant material between the Contracting Agency, the Contractor and the nursery. However, there will be no acceptance of any plant material during this inspection. All plant material shall meet the requirement specified in Subsection [726.02.01](#), "Certificates and Samples."
- B. All plant material will be inspected by the Engineer on arrival at the site or storage area for quality. These inspections shall determine the acceptance or rejection of the plant material based on quality as specified in Subsection [212.02.03](#), "Quality of Plant Materials." This inspection is for quality of plant material only and does not constitute final acceptance. Plants which are rejected shall be immediately removed from the holding area and replaced by acceptable plants at no additional cost to the Contracting Agency.
- C. All plant material will be continually inspected by the Engineer from the time of arrival at the holding area, during planting and through the plant establishment period. Plants may be individually rejected during this time based on mechanical damage, quality or physical change of the plant which is not normal to the plant or to the season of the year. Plants which are rejected shall be immediately removed from either the holding area or the project and replaced by the Contractor at no additional cost to the Contracting Agency.

212.02.06 SUBSTITUTION OF PLANTS

- A. No substitution of plant material will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since

the award of the contract. If substitution is permitted, it can be made only with written approval by the Engineer. The nearest variety, size, and grade as approved by the Engineer shall then be furnished.

212.02.07 TEMPORARY STORAGE

- A. Plant material delivered and accepted at the project site shall be planted immediately. Plants that cannot be planted within 1 day after arrival shall be "held" in accordance with accepted horticultural practice, and as follows:
 - 1. Balled and burlapped plants shall have the root ball protected by moist earth, sawdust, or other acceptable material.
 - 2. Container grown plants shall be placed under shelter and kept moist. Plants stored under temporary conditions shall be protected at all times from extreme weather conditions, and shall be kept moist.

212.02.08 PLANTING SOIL

- A. Planting soil shall conform to the applicable requirements of Section [726](#), "Roadside Materials."

212.02.09 LUMBER

- A. Lumber for header boards and planter boxes, as may be called for on the plans, shall conform to the requirements of Section [718](#), "Timber."

212.02.10 MULCH

- A. Hay or straw, wood cellulose fiber, wood chips and bark shall conform to the applicable requirements of Subsection [726.03.04](#), "Mulch."

CONSTRUCTION

212.03.01 SITE PREPARATION

- A. This work shall consist of all work necessary, as set forth in the contract documents, such as roadway construction, drainage facilities, grading, cleaning, etc., to prepare the area for the actual landscaping work. All work as set forth herein shall be completed and approved by the Engineer prior to beginning any preparation of the planting areas.

212.03.02 LAYOUT OF PLANTING

- A. The Contractor will designate, by means of stakes or other approved markings, the ground location of each randomly placed plant. Areas of massed or uniform solid plantings shall be marked at their outer extremes only. The Engineer's approval of plant stakeout will be required prior to the commencement of the preparation of planting areas.
- B. In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, and the final planting or ground covers.

212.03.03 PREPARATION OF PLANTING AREAS

- A. During the preparation of planting areas, all clods, rocks, or other debris over 1 inch in dimension shall be removed from both cultivated areas and backfill material, and disposed of as directed by the Engineer. In addition thereto, the following requirements will apply:

1. **Planter Boxes:** Backfill material shall consist of 1 part organic matter to 3 parts soil by volume. This material shall be thoroughly and uniformly mixed before placing in the planter boxes. After placing in the planter box, the material shall be watered until it is completely saturated. Sufficient backfill mixture shall be added and adequately wet so that after settlement has taken place, the material is approximately 2 inches below the top of the box.
2. **Planting Beds:** The soil preparation shall not be initiated until all grading has been completed and the irrigation system has been installed, tested, adjusted, and accepted by the Engineer. The ground surface within the area shall then be loosened and thoroughly pulverized to a depth of 6 inches. When required, organic matter, commercial fertilizer, or agricultural minerals and other additives shall be incorporated at the rate specified in the contract documents, and shall be thoroughly and uniformly tilled into the soil to a depth of 6 inches. The area shall then be brought to a plane in conformance to the elevations shown on the plans.
3. **Seed Beds:** The soil preparation shall be the same as specified for planting beds.
4. **Planting Holes:** Prior to drilling holes, the proposed location of the irrigation lines shall be designated by means of stakes or other approved markings. In the event of conflict between individual planting holes and irrigation lines, the planting holes in question shall be relocated under the direction of the Engineer.
 - a. All holes shall be drilled with a power auger to the dimensions specified in the contract documents unless otherwise approved by the Engineer. Holes shall be drilled at the location of each individual plant, the stake or marking being considered the center of the hole. The holes shall have vertical walls and horizontal bottoms.
 - b. When required, organic matter, commercial fertilizer, or agricultural minerals and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the holes prior to backfilling. After backfilling the holes, the material shall be saturated with water to the full depth of the hole and until ponding appears in the basin. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.
5. **Planting Trenches:** Trenches shall be excavated to the dimensions specified in the contract documents and shall be centered on the planting line as staked or otherwise marked. When required, organic matter, commercial fertilizer, or agricultural minerals and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the trenches prior to backfilling. After backfilling the trenches, the material shall be saturated with water to the full depth of the trench. Cross checks may be formed as necessary to permit ponding of water during the saturation period but must be removed prior to planting. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

212.03.04 PLANTING

- A. No planting shall be done in any area until the Contractor has received the Engineer's approval that the area concerned has been satisfactorily prepared as provided in Subsection [212.03.03](#), "Preparation of Planting Areas."

- B. No more plants shall be distributed within the project area on any 1 day than can be planted and watered on that day.
- C. Any planting done in soil that is too wet or dry or not properly conditioned as provided herein will not be accepted. No payment will be made for such planting and any further planting work will be suspended until the Contractor has complied in every way with the specifications.
 - 1. **Plants (Group A):** Nursery stakes supporting plants in containers shall be removed and the plants pruned, if necessary, as specified herein, after planting.
 - a. Containers shall be cut 3 times from top to bottom.
 - b. Plants shall be removed from the containers in such a manner that the ball of earth surrounding the roots is not broken, and the plants shall be planted and watered as hereinafter specified immediately after removal from the containers.
 - c. Containers shall not be cut prior to delivery of the plants to the planting areas.
 - 2. **Plants (Group B):** Balled and burlapped material shall have all strings or cords cut, and the burlap shall be laid back from the top half of the ball. This shall be done only after the plant is placed in its final position and before completion of the backfill.
 - 3. **Plants (Group C):** As soon as each plant is removed from its container, it shall be planted in the prepared planting bed, in a hole previously prepared with a broad, blunt end trowel. The plant shall be carefully lifted with the trowel, inserted in the hole, and the earth shall be gently firmed and watered around it to eliminate air pockets.
 - a. Plants brought to the jobsite in plastic or clay pots shall be tapped loose from their containers in such a manner that the ball of earth surrounding the roots is not broken, and then immediately planted. Plants which are brought to the jobsite in peat pots may be planted in the pots. No plants brought to the jobsite in pony pacs or bare root will be accepted.
 - b. Plants shall be watered as hereinafter specified immediately after planting.
 - c. Roots of plants not in containers shall be kept moist and covered at all times and shall not be exposed to the air except while actually being placed in the ground.
 - d. Plants shall be set in a plumb position in the backfill mixture material to such a depth that, after the soil has settled, the top of the plant ball will be 2 inches below finished grade.
 - e. Plants shall be planted in such a manner that the roots will not be restricted or distorted. Soil shall be firmed around the roots or ball of the plant during planting operations by foot tamping or saturation with water. Any plants which have settled deeper than specified in the above paragraph shall be raised back to the required level, or replaced, at the option of the Contractor.
 - 4. **Plants (Group D):** The seed bed shall be in a moist, friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding will not be accepted. No payment will be made for seeding when the soil condition is considered unsatisfactory and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

- a. Seed shall be sown from standard mechanical grass seeding equipment with adjustable gate, as appropriate to the area, and at the rate shown on the plans. After sowing, the seed shall be embedded by light rolling. The Contractor shall exercise care to avoid leaving footprints or other depressions in the compacted seed bed.
- b. Organic mulch shall be evenly applied immediately after the seed bed has been firmed, with manure spreaders, mulch blowers or other approved equipment. The mulch shall be spread at the rate of 1 cubic yard per 1,000 square feet. As soon as mulch is in place, the surface of the seed bed shall be dampened with a fine spray from a nozzle until the mulch is thoroughly moist.

212.03.05 STAKING AND GUYING

- A. All staking and guying shall be done concurrently with the planting operation.
 1. **Staking:** Plants that are to be staked will be specified in the contract documents.
 - a. The size, number of stakes, and the depth to be driven shall be as specified in the contract documents, or as approved by the Engineer.
 - b. The stakes shall be placed against but not through the plant ball in the case of plants (Groups A and B).
 2. **Tree Ties:** The method of attaching the ties to stakes and trees shall provide firm connection, but the trunk loop shall be sufficiently loose to prevent damage to the bark. It may, on occasion, as determined by the Engineer, be considered necessary to use number 10 gage galvanized wire encased in at least 1/2-inch rubber hose as tree ties, in which case all connections shall be twisted.
 3. **Guying:** Plants that are to be guyed will be specified in the contract documents.
 - a. All guying shall be done as specified in the contract documents or as approved by the Engineer.

212.03.06 PRUNING

- A. Pruning shall be done as determined by the Engineer after plant materials are planted.
- B. Pruning of evergreen coniferous plants will not be permitted except under the direction of the Engineer.

212.03.07 WATERING

- A. The Contractor shall make arrangements for furnishing and applying water at no additional cost to the Contracting Agency.
- B. Valves at meters shall be kept closed at all times, except while the irrigation system is actually in use.
- C. Precautions shall be taken during times when the irrigation system is on to prevent water from wetting vehicles, pedestrians, and pavement. Any erosion, slippage, or settlement of the soil caused by watering shall be repaired by the Contractor at no additional cost to the Contracting Agency.
- D. Compliance with the provisions in this section shall not relieve the Contractor of responsibility for the replacement of plants as provided hereinafter.

1. Plants (Groups A and B):

- a. All plants shall be watered immediately after planting. Water shall be applied in a moderate stream until the backfill soil around and below the roots or ball, or earth around each plant, is thoroughly saturated. Where watering is done with a hose, a metal or plastic pressure reducing device approved by the Engineer shall be used. Under no circumstances shall the full force of the water from the open end of a hose be allowed to fall within the basin around any plant.
- b. After the first watering, water shall be applied to all plants as often and in sufficient amount as conditions may require to keep the soil moist, above, around, and below the root systems of the plants during the life of the contract. After the installed irrigation system has been accepted, it may be used to water the planted area.
- c. Any additional watering measures required to initially saturate the backfill, water the plants immediately after planting, or to maintain the plants in a satisfactory growing condition shall be anticipated and furnished by the Contractor at no additional cost to the Contracting Agency.

2. Plants (Group C):

- a. As soon as all the perennials in a given area have been planted, water shall be applied to that area in a fine mist from an atomizing nozzle until the entire planting bed is saturated. This initial watering shall not be done with the installed irrigation system.
- b. After the first watering, water shall be applied to the areas as often and in sufficient amount as conditions may require to keep the soil wet, above, around, and below the root systems of the plants during the life of the contract.

3. Plants (Group D):

- a. The seed bed shall be kept in moist but not soggy condition until after germination. After germination, water shall be applied to the areas as often and in sufficient amount as conditions may require during the life of the contract.
- b. The installed turf irrigation system may be used to water those areas as long as care is taken to prevent erosion or other damage to the area. However, should the irrigation system prove to be unsatisfactory, other means of watering, as approved by the Engineer, shall be used until germination is complete and all grass has attained a height of 1 inch. After a uniform stand of grass which has attained a height of 1 inch has been achieved over the entire turf area, the installed turf irrigation system may be used to keep the area moist.

212.03.08 REPLACEMENTS**1. Plants (Groups A, B, and C):**

- a. During the planting and plant establishment period of the project, all plants that show signs of failure to grow normally or which are so injured or damaged as to render the plants unsuitable for the purpose intended, as determined by the Engineer, shall be removed and replaced in kind. The Engineer will

inspect the work on the first and second working day of each week during the planting and plant establishment periods, and will mark or otherwise indicate all plants to be replaced. The Contractor shall complete replacement of such plants as soon as possible, but in no case shall the Contractor take more than 2 weeks to complete the replacement.

- b. Replacement plants shall be furnished and planted by the Contractor at no additional cost to the Contracting Agency.
- 2. **Plants (Group D):** The Engineer will inspect the turf at the time of the first cutting and will designate any areas which need reseeding. Seed used for reseeding shall be the same types and amounts as specified for the initial planting and shall be planted in accordance with the contract documents or as directed by the Engineer. The cost of the seed and actual reseeding shall be borne by the Contractor.

212.03.09 FERTILIZERS, AGRICULTURAL MINERALS AND ADDITIVES

- A. When fertilizers or other agricultural minerals or additives are called for, the fertilizers, minerals, and additives shall be applied at the rates and as specified in the contract documents or as approved by the Engineer.

212.03.10 PROTECTION OF EXISTING FACILITIES

- A. Any existing buildings, equipment, piping, pipe covering, sprinkling systems, sewers, sidewalks, landscaping, utilities, roadways, or any other improvement of facilities damaged due to the Contractor's operations shall be repaired or replaced by the Contractor at no additional cost to the Contracting Agency as directed by the Engineer.

212.03.11 PLANT ESTABLISHMENT WORK

- A. This work shall consist of watering and caring for all of the plants and planting areas, the replacement of plants, the weeding and general maintenance as specified in the contract documents.
- B. The plant establishment period shall begin at such time as all planting has been accomplished and all other work has been completed and the project is in a neat and clean condition.
- C. The length of the plant establishment period shall be as specified in the contract documents.
- D. The Engineer will notify the Contractor in writing of the start of the plant establishment period and will furnish statements regarding days credited to the plant establishment period after said notification.
- E. The time required for plant establishment work shall be considered as included in the total time limit specified for the contract. Any day upon which no work is required, as determined by the Engineer, will be credited as one of the plant establishment days regardless of whether the Contractor performs plant establishment work.
- F. Any day when the Contractor fails to adequately water plants, replace unsuitable or damaged plants, do weed control, adjust or replace bracing and ties, or other work, as determined necessary by the Engineer, will not be credited as one of the plant establishment days. No extension of contract time will be granted beyond the final completion date by reason of failing to perform plant establishment work on days when such work is necessary.

- G. All plants shall be kept watered as provided in Section [210](#), "Watering."
- H. Surplus earth, papers, trash, and debris, which accumulate in the planted areas shall be removed and disposed of in accordance with the provisions in Subsection [107.14](#), "Disposal of Material Outside Project Right-of-Way," and the planted areas shall be so cared for as to present a neat and clean condition at all times. During the plant establishment period, trees and shrubs shall be pruned or headed back by the Contractor at no additional cost to the Contracting Agency, when and as directed by the Engineer.
- I. In order to carry out the plant establishment work, the Contractor shall furnish sufficient men and adequate equipment to perform the work during the plant establishment period.

METHOD OF MEASUREMENT

212.04.01 MEASUREMENT

- A. The quantity of materials and work measured for payment will be materials and work complete and in place. The various items will be measured in the manner and in the units as follows:
 - 1. Site preparation will be measured by the acre or square foot.
 - 2. Planting soil will be measured by the cubic yard.
 - 3. Preparing soil (plant boxes) will be measured by the cubic foot.
 - 4. Preparing soil (plant bed) will be measured by the square foot.
 - 5. Fertilizer or agricultural minerals will be measured by the pound determined by marked quantities and sack count, by the ton, by each stick or pellet, or by the gallon, all as designated in the proposal.
 - 6. Organic matter will be measured by the cubic yard, or determined by marked quantities and sack count.
 - 7. Mulch will be measured by the cubic yard or determined by marked quantities and sack count.
 - 8. Hole preparation will be measured by the actual number of holes prepared.
 - 9. Trench preparation will be measured by the linear foot and the depth and width of the trench will be designated in the contract documents.
 - 10. Tree rings will be considered incidental to "Hole Preparation" and there will be no measurement or payment therefor.
 - 11. Mowing strips will be measured by the number of linear feet along the top of the strip.
 - 12. Planter boxes will be measured by the number of boxes placed on the project that conform to the sizes specified in the contract documents.
 - 13. Header boards will be measured by the thousand foot board measure (Mfbm).
 - 14. Plants in Groups A through C will be measured by the number of plants in each group.
 - 15. Plants in Group D will be measured by the square foot in place.
 - 16. The unit of measure for Plant Establishment Work will be lump sum.

- B. All measurements will be made in accordance with Subsection [109.01](#), "Measurement of Quantities."

BASIS OF PAYMENT

212.05.01 PAYMENT

- A. The accepted quantities for items of this section measured as provided in Subsection [212.04.01](#), "Measurement," will be paid for at the contract unit price bid for the type, size, group, or whatever information is necessary for identification, and so identified in the proposal. Such payment shall be full compensation for all the labor, materials, and incidentals necessary to complete the work.
- B. Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.
- C. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."
- D. Payment will be made under:

PAY ITEM	PAY UNIT
Site Preparation including removal of excess soil	Acre, Square Foot
Planting Soil	Cubic Yard
Preparing Soil (plant boxes)	Cubic Foot
Preparing Soil (planting bed)	Square Foot
Fertilizer (type and class)	Pounds, Ton, Each, Gallons
Organic Matter (type)	Cubic Yard
Mulch (type)	Cubic Yard
Hole Preparation	Each
Trench Preparation	Linear Foot
Mowing Strips	Linear Foot
Planter Boxes (type, size)	Each
Header Boards (type, lumber, size)	Mfbm
Plants (Group A - C)	Each
Plants (Group D)	Square Foot
Plant Establishment Work	Lump Sum

SECTION 306**LIME STABILIZED SUBGRADE****DESCRIPTION****306.01.01 GENERAL**

- A. This work consists of stabilizing in place subgrade material, by combining lime and water with the pulverized subgrade material to the specified depth and compacting the mixture to the specified density, in conformance to the lines, grades, and dimensions shown on the plans and as specified in these specifications and the Special Provisions.

MATERIALS**306.02.01 SUBGRADE MATERIAL**

- A. Subgrade material shall be the native in-situ soil or imported embankment material.
- B. The material to be stabilized shall be free of organic materials or other deleterious matter, and shall be limited to such a size that all the material can be passed through the mixing machine at each operation.
- C. When sulfates are found in the subgrade and embankment material, the subgrade shall be stabilized in accordance with the table below for recommended mellowing time.
- D. Soluble sulfate content shall be determined in accordance with California Test Method 417 modified to use 10 parts water to 1 part soil.

HYDRATED LIME SLURRY - SULFATE CHART

AMOUNT OF SULFATES %	RECOMMENDED MELLOW TIME
0.0 - 0.3	None
0.3 - 0.5	1 Day
0.5 - 0.8	2 - 3 Days
0.8 - 1.0	* Double Application

When sulfate rate is above 0.8 percent, Engineer review and approval is required.

* Double Application - One half of the specified hydrated lime shall be applied, mixed, and mellowed for 5 days at above optimum moisture conditions. The second half of the slurry shall then be applied, mixed, and compacted.

306.02.02 LIME

- A. Lime shall be either a hydrated lime or quicklime, and shall conform to ASTM C977.
- B. Lime may only be used in the production of a lime slurry.
- C. The direct application of dry hydrated lime or quicklime to the subgrade material is strictly prohibited.
- D. All lime shall come from a single source. If the source is changed, new information shall be submitted for the Engineer's approval.
- E. All batches of lime furnished to the project shall have the supplier's certificate of compliance.

306.02.03 WATER

- A. Water used for mixing lime slurry or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.
- B. Water shall be tested in accordance with and shall meet the requirements of AASHTO T26.
- C. Water known to be of potable quality may be used without testing.

CONSTRUCTION**306.03.01 PROPORTIONING**

- A. Before commencing lime treatment work, the Contractor shall furnish in writing to the Engineer a proposed mix design determined by a testing laboratory under the direction and control of a registered professional engineer.
- B. The mix design shall be determined using the in-place soils to be stabilized and lime from the proposed supplier and shall determine the following:
 - 1. Percent of lime and rate of application of lime slurry in the treated subgrade material.
 - 2. Optimum water content during mixing, curing, and compaction.
 - 3. Gradation of in-situ mixture after treatment.
 - 4. Additional mixing or equipment requirements.
 - 5. Mellowing time requirements, if needed.
- C. The mix design shall comply with the following requirements:
 - 1. Minimum pH: 12.4 after completion of initial mixing with lime at ambient temperature, in accordance with Eades-Grim pH test method (ASTM C977, Appendix).
 - 2. Plasticity Index: Less than 3, in accordance with ASTM D4318, after 16 hours of cure time with the lime.
 - 3. Swell Potential: 1 percent or less vertical expansion of an air dried soil when inundated with water and allowed to swell at a confined pressure of 60 psf.
 - 4. Minimum Hydrated Lime Content: 5.0 percent by dry weight of the combined lime/soil mixture, in accordance with ASTM D3155.
 - 5. Minimum Unconfined Compressive Strength: At least 160 psi in 5 days of curing at 100 degrees F when tested in accordance with ASTM D1633, Method A.

306.03.02 SUBGRADE PREPARATION

- A. Subgrade material to be stabilized shall be scarified and thoroughly broken up to the full depth and width to be lime treated. The material shall then be shaped and sized for the addition of lime slurry.
- B. When the design requires treatment to a depth greater than 1 foot, the subgrade soil shall be treated in 2 equal layers.
 - 1. The top layer of soil shall be treated in place, and then removed and stockpiled. The moisture content of the stockpile shall be maintained at the specified moisture.
 - 2. The lower layer of soil to be treated shall then be treated and allowed to mellow in place.

3. After final mixing, the lower layer shall be compacted.
4. The stockpiled lime-soil mixture shall then be placed, mixed, and compacted.

306.03.03 LIME APPLICATION

- A. Lime shall be applied as a slurry to the subgrade material at the rate specified for the depth of subgrade treatment shown.
 1. The treatment rate shall be determined from a design using the subgrade materials, and shall meet the requirements in Subsection [306.03.01](#), "Proportioning."
 2. Rate of application shall be verified using methods outlined in ASTM D3155.
 3. Lime slurry shall be spread only on that area where the mixing operations can be completed during the same working day.
 4. Lime slurry shall not be left exposed to the air for more than 4 hours.
 5. No traffic other than the mixing equipment shall be allowed to pass over the spread lime slurry until after completion of mixing.
- B. The Engineer reserves the right to vary the rate of application of lime from the specified application rates during the progress of construction as necessary to maintain a pH of the lime/soil mixture above 12.4 and the desired characteristics of the treated subgrade.
- C. The lime shall be mixed with water in approved slakers and applied as a slurry by approved trucks with distributors or applicators approved by the Engineer.
 1. When using dry hydrate to make a slurry, agitators are mandatory in distributor trucks.
 2. The distribution of lime slurry shall be attained by successive applications over a measured section of subgrade until the proper amount of lime has been spread.
 3. The amount of lime spread shall be the amount required for mixing to the specified depth which will result in the percentage determined in the mix design.

306.03.04 MIXING

- A. The lime stabilized subgrade shall not be mixed when the ambient air temperature at ground level is below 40 degrees F or as approved by the Engineer, or when it is rainy, or when the temperature of the subgrade material is below 35 degrees F.
- B. The lime subgrade shall be maintained at a temperature of 35 degrees F or above until the lime stabilized material has been compacted.
- C. The full depth of the stabilized subgrade layer shall be mixed with an approved mixing machine.
 1. The use of disc plows or blades are strictly prohibited except in areas specified by the Engineer.
 2. The mixing machine shall make 2 or more coverages, as determined by the Engineer.
 3. Water shall be added to the subgrade material during mixing to provide a moisture content at least 3 percent above the optimum moisture content as determined by the mix design to ensure chemical reaction of the lime and subgrade material.
 4. This moisture content shall be maintained throughout the mellowing and curing time.
 5. During the mellowing period, the material shall be sprinkled as directed.

- D. Mixing and remixing shall be done as necessary to assist the lime-soil reaction, and shall continue until the combination of lime slurry and subgrade materials is free of streaks or pockets of lime, and the mixture is of uniform consistency and contains no clods or lumps greater than 1 inch or less than 60 percent passing the No. 4 sieve when tested dry.
- E. After the required mellowing time, the lime stabilized subgrade material shall be uniformly mixed for final mixing.
- F. After final mixing, the treated subgrade material shall be tested for plasticity index in accordance with ASTM D4318 and for compressive strength.
 - 1. The lime mixture shall develop compressive strength of at least 160 psi in 5 days of curing at 100 degrees F when tested in accordance with ASTM D1633, Method A.
 - 2. Cylinders shall be molded from treated soil within 2 hours of final mixing with the material compacted to at least 95 percent compaction at the field moisture content.
 - 3. Moisture density field relationships for the treated soil shall be determined in accordance with ASTM D698.
- G. The treated subgrade shall then be tested for lime content.
 - 1. When the percentage of lime is found to be deficient less than 0.5 percent from the design, the material may be left in place.
 - 2. When the percentage of lime is deficient between 0.5 percent and 1.0 percent, payment will be made in accordance with Subsection [306.05.01](#), "Payment."
 - 3. When the percentage of lime is deficient more than 1.0 percent, the entire area shall be reprocessed at no additional cost to the Contracting Agency.

306.03.05 COMPACTION

- A. Compaction of the lime stabilized subgrade shall begin immediately after final mixing.
 - 1. The material shall be aerated or sprinkled as necessary to maintain the moisture content of the mixture between 0 to 3 percent above the optimum moisture content.
 - 2. The field density of the compacted mixture shall be at least 95 percent of the maximum laboratory density.
 - 3. The optimum moisture content and maximum laboratory density shall be determined in accordance with ASTM D698.
- B. Initial compaction shall be by means of sheep-foot rollers or segmented wheel rollers. Final rolling shall be with steel-wheeled or pneumatic-tired rollers. Areas inaccessible to rollers shall be compacted to the required compaction by other means satisfactory to the Engineer.
- C. In addition to the requirements specified for density, the full depth of the lime treated subgrade shown on the Drawings shall be compacted to the extent necessary to remain firm and stable under construction equipment.
 - 1. All irregularities, depressions, or weak spots which develop as determined by the Engineer shall be corrected immediately by scarifying the areas affected, adding or removing materials as required, reshaping, and recompacting by moisture conditioning and rolling.
 - 2. After each section is completed, tests will be made by the Engineer.

3. If the material fails to meet the density requirements, the material shall be reworked to meet these requirements.
4. Should the material, due to any reason or cause, lose the required stability, density, or finish before the next course or pavement is placed, the material shall be recompact and refinished at no additional cost to the Contracting Agency.

306.03.06 FINISHING AND CURING

- A. The surface of each layer of lime treated material shall be kept moist for a minimum of 1 day before further courses are added or any traffic is permitted, unless otherwise directed by the Engineer.
- B. The moisture cured duration may be reduced if a non-yielding surface is obtained to support construction traffic and either the next layer of treated soils are placed or the pavement layer is constructed, as approved by the Engineer.
- C. After the final layer of lime stabilized subgrade has been compacted, the subgrade shall be brought to the required lines and grades in accordance with the typical sections.
 1. If the surface of the finished layer is above the grade tolerance specified in this section, the excess material shall be trimmed, removed, and disposed of.
 2. No loose material shall be left in place.
 3. After trimming, the material shall be rolled with steel-wheeled or pneumatic-tired rollers.
 4. The finished surface shall not deviate by more than 0.04 feet from the actual finish grade.
 5. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.
- D. The finish thickness of the lime stabilized subgrade shall not be deficient by more than 1 inch from the planned thickness at any point. If the thickness is deficient by more than 1 inch, the pavement structural section shall be adjusted by the Contractor to compensate for the deficiency in stabilized subgrade thickness, subject to the approval of the Engineer and at no added cost to the Contracting Agency.

METHOD OF MEASUREMENT

306.04.01 MEASUREMENT

- A. The area of lime stabilized subgrade will be measured for payment by the square yard complete in place and accepted.

BASIS OF PAYMENT

306.05.01 PAYMENT

- A. Payment shall be made at the contract unit price per square yard for the lime stabilized subgrade of the thickness specified. The price shall be full compensation for furnishing all labor, material including the lime, tools, equipment and incidentals, and for doing all the work involved in constructing the lime stabilization complete in place, as shown on the plans, and as specified in these specifications and the Special Provisions, and as directed by the Engineer. The pavement structural section shall be adjusted by the Contractor to compensate for any deficiency in stabilized subgrade thickness.

B. Payment will be made under:

PAY ITEM	PAY UNIT
Lime Stabilized Subgrade.....	Square Yard

Payment Table

% Deviation from design Lime Content	Pay Schedule % of Unit Price
less than 0.5%	100%
minus 0.51 to 0.6%	80%
minus 0.61 to 0.7%	60%
minus 0.71 to 0.8%	40%
minus 0.81 to 0.9%	20%
minus 0.91 to 1.0%	0%

SECTION 407**SEAL COAT****DESCRIPTION****407.01.01 GENERAL**

- A. This work shall consist of an application of bituminous material on a compacted and bonded bituminous surface and blotter sand, if required, in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIAL**407.02.01 BITUMINOUS MATERIAL**

- A. Unless otherwise specified in the Special Provisions, the type and grade of bituminous material shall be SS-1h or CSS-1h asphalt emulsion. The grade may be changed by the Engineer during construction.
- B. The bituminous material shall meet the applicable requirements of Section [703](#), "Bituminous Materials." The bituminous material may be conditionally accepted at the source.
- C. The emulsion shall be cut back by warm water. Water shall be added to the emulsion in the quantity of 50 percent of the emulsion by weight.

407.02.02 SAND BLOTTER

Sand blotter shall meet the requirements of Subsection [705.03.06](#), "Sand Blotter." The material may be accepted in stockpile at the source.

CONSTRUCTION**407.03.01 EQUIPMENT**

- A. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. The equipment shall meet the requirements of Subsection [405.03.01](#), "Equipment."

407.03.02 WEATHER LIMITATIONS

- A. Bituminous material shall not be applied:
1. On a wet surface.
 2. When the surface temperature is below 50 degrees F.
 3. When weather conditions, in the opinion of the Engineer, would prevent the proper construction of the seal coat.

407.03.03 PREPARATION OF SURFACE

- A. Immediately before applying the bituminous material, the surface to be sealed shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary.

- B. The process of cleaning shall continue until dirt and loose material are removed from the entire width of the surfacing.

407.03.04 APPLICATION OF BITUMINOUS MATERIAL

- A. Bituminous material shall not be spread later in the day than will permit the stopping of traffic control prior to darkness.
- B. Bituminous material shall be applied to only one designated traffic lane at a time and the entire width of the lane shall be covered in one operation.
- C. The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer.
- D. The temperature of the bituminous material shall conform to the applicable requirements of Subsection [406.03.04](#), "Application of Bituminous Material."
- E. The seal coat shall be applied in a manner to offer the least inconvenience to traffic and to permit 1-way traffic without pickup or tracking of the bituminous material.
- F. When seal and screenings are to be applied to the central portion of the pavement, the shoulder seal coat shall be applied at least 4 days in advance of the application of the adjacent surface treatment requiring screenings, and the seal coats shall be applied so that the joints between the 2 types will present a neat and uniform appearance true to the line shown on the typical cross section and as established by the Engineer.

407.03.05 APPLICATION OF BLOTTER MATERIAL

- A. The applicable requirements of Section [406](#), "Prime Coat," shall apply to this section when sand blotter is required.

METHOD OF MEASUREMENT

407.04.01 MEASUREMENT

- A. The quantity of bituminous material to be measured for payment will be the number of tons or square yards conforming to all the requirements in the completed work.
- B. All measurements will be made in accordance with Subsection [109.01](#), "Measurement of Quantities."

BASIS OF PAYMENT

407.05.01 PAYMENT

- A. The accepted quantity of material measured as provided in Subsection [407.04.01](#), "Measurement," will be paid for at the contract unit price bid per ton or square yard for bituminous material.
- B. The above price shall be full compensation for furnishing the material, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing seal coat as shown on the plans or established by the Engineer.
- C. The Contracting Agency reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no adjustment in unit price shall be allowed by reason of such increase or decrease.
- D. Sand blotter will be paid for in accordance with Section [406](#), "Prime Coat."

- A. When an item for seal coat does not appear in the proposal, but it is shown on the plans or Standard Drawings, seal coat will be considered as incidental to the subsequent paving and compensation be included in the contract prices for other items of work.
- B. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."
- C. Payment will be made under:

PAY ITEM**PAY UNIT**

Emulsified Asphalt Seal Coat (Type).....Ton, Square Yard

SECTION 501

PORTLAND CEMENT CONCRETE

DESCRIPTION

501.01.01 GENERAL

- A. This work shall consist of Portland cement, fine aggregate, coarse aggregate, water and when specified, an air entraining admixture, proportioned, mixed, placed, and cured as herein specified. All concrete shall meet the most current requirements of American Concrete Institute (ACI) with the following additions and/or exceptions indicated in this specification.
- B. As used in this section, the term Portland Cement shall be considered synonymous with the term Hydraulic Cement.

501.01.02 QUALITY CONTROL TESTING AND INSPECTION

- A. The testing and inspection of Portland cement concrete shall comply with this specification. The inspection of the mixing plant shall comply with the ACI 311, Chapter 2. In Clark County unincorporated areas and if required by other Contracting Agencies, all field and laboratory sampling and testing for project control shall be performed by NAQTC or ACI certified technicians in an AASHTO or A2LA accredited laboratory. The concrete designs shall comply with Tables 1 and 2 and the IQAC website http://www.accessclarkcounty.com/depts/public_works/pages/iqac.aspx or comply with Contracting Agency requirements.

MATERIALS

501.02.01 GENERAL

- A. Materials shall meet the requirements of the following sections and subsections:

Materials	Section
Aggregate for Portland Cement Products	<u>706</u>
Concrete Curing Materials and Admixtures	<u>702</u>
Portland Cement	<u>701</u>
Water	<u>722</u>

501.02.02 GRADATION REQUIREMENTS

- A. Refer to ACI 304 Chapters 2.1 and 2.2, and comply with the gradation requirements specified in Section [706](#), "Aggregates for Portland Cement Products," and the following:
 - 1. The gradation requirements represent the extreme limits in determining the suitability of material. The gradation from any one source shall maintain a uniformity such that variations in the fineness modulus will not exceed 0.2 from the "Base Fineness Modulus."
 - a. The "Base Fineness Modulus" shall be the average of the most recent 10 fineness modulus values (or the average of all preceding values if less than 10 have been completed) from any one source.

- b. Fine aggregate from any one source having a variation in fineness modulus exceeding ± 0.2 as prescribed above will be rejected, or at the discretion of the Engineer, may be accepted subject to approved changes.
 - c. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages, by weight, of material retained on each of U.S. Standard sieves No. 4, No. 8, No. 16, No. 30, No. 50, and No. 100, and dividing by 100.
- 2. Fine aggregates from different sources of supply shall not be mixed or stored in the same stockpile and shall not be used alternately in the same class of construction or job mix without written permission. Such permission will be contingent on amending the job mix and batch masses as necessary to protect the quality of the concrete produced.
 - 3. If the fine aggregate for a job mix is to be a composite material from 2 or more sources, material from respective sources shall be blended by methods that will maintain the degree of uniformity of gradation required by these specifications.
 - 4. Adequate supplies of aggregate shall be produced and stockpiled sufficiently in advance of construction operations to permit sampling and testing before use.
 - 5. Coarse aggregates which vary in gradation shall be placed in separate stockpiles or bins and recombined in approved proportions. Different sizes of aggregates shall be stored in stockpiles sufficiently removed from each other to prevent the materials from becoming intermixed.
 - 6. If the Contractor changes the source of any size of aggregate, a new mix design shall be submitted to the Engineer for approval.

501.02.03 ADMIXTURES

- A. Refer to ACI 212. Air-entraining admixtures and water reducers and retarders shall conform to the requirements of Subsection [702.03.02](#), "Air-Entraining Admixtures," and Subsection [702.03.03](#), "Admixtures Other Than Air-Entraining."
- B. Admixtures that are not listed in the mix design shall not be used without written permission from the Engineer, except as otherwise provided in these specifications or in the Special Provisions.
- C. Admixtures used in Class EA Concrete, Modified shall be an approved chemical admixture for concrete, meeting the requirements of ASTM C494. Use Type "A" admixture when the anticipated high temperature for the day is 80 degrees F or below. Type "D" admixture shall be used when the anticipated high temperature is above 80 degrees F. The water-cement ratio shall not be adjusted once the chemical admixture has been incorporated into the mix.
- D. Admixtures shall not be used to replace cement. Admixtures containing chlorides as Cl^- in excess of 1 percent by weight shall not be used in prestressed concrete. If admixtures are used to entrain air, to reduce the water-cement ratio, to retard or accelerate setting time, or to accelerate the development of strength, the admixtures shall be used at the dosage specified in the mix design, or in the contract documents, or as provided by the Engineer.
- E. When the use of an air-entraining agent is specified, it shall be added in a quantity conforming to Table 2 in Subsection [501.03.04](#), "Classifications and Proportions." It shall be measured into each batch by equipment and methods approved by the Engineer. Adjustments shall be made in the weights of the aggregates used per batch to compensate for increased yield due to air-entrainment so that the quantities of cement per

- cubic yard of concrete remain constant. Such adjustments shall be made by decreasing the weight of fine aggregate without changing the weight of coarse aggregate unless otherwise approved by the Engineer.
- F. When a High Range Water Reducing admixture is used, the initial slump is waived and the slump of the concrete after the admixture is added shall not exceed 8 inches.
 - G. Admixtures shall be measured accurately into each batch by methods approved by the Engineer.
 - H. Except as otherwise provided for air-entraining agents, samples of admixtures proposed for use shall be submitted by the Contractor to the Engineer in advance of intended use to permit tests to be made to determine compliance with claimed properties.
 - I. Any type of admixture shall be uniform throughout its use in the work. Should it be found that the admixture as furnished is not uniform, its use shall be discontinued.
 - J. Admixtures shall be dispensed in liquid form. Dispensers for admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. Dosages of admixtures shall not vary from the dosage indicated in the mix design or as approved by the Engineer by more than 5 percent, with the exception of air entraining admixtures where the dosage is required to achieve the specified range. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement. If more than one admixture is used, each shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.
 - K. When water-reducing agents or water-reducing retarders are used, the permitted dosage of the admixture shall not exceed that which will result in an increase in the drying shrinkage of the concrete of 20 percent when used in precast, prestressed concrete; 10 percent when used in cast-in-place prestressed concrete; 10 percent when used in cast-in-place reinforced concrete; or 3 percent when used in non-reinforced concrete pavements.
 - L. Water reducers shall reduce the water demand of concrete for a given slump at least 7 percent when used at the maximum dosage recommended by the manufacturer. Set retarders shall not be used in greater dosages than those recommended by the manufacturer, nor more than that needed to obtain the desired retardation. The strength of the concrete containing the admixture in the amount approved by the Engineer shall at the age of 48 hours and longer, be not less than that of similar concrete without the admixture.
 - M. When the Contractor proposes to use an air-entraining admixture which has been previously approved, the Contractor shall submit a certification stating that the admixture is the same as that previously approved.
 - N. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.
 - O. Before or during construction, the Engineer may require that the admixture selected be further tested to determine its effect upon the strength of the concrete. The 7-day compressive strength of concrete containing the admixture under test shall not be less than 88 percent of the strength of concrete made with the same materials, the same cement content, and consistency, but without the admixtures.

- P. Subject to the following conditions, pozzolan conforming to Subsection [702.03.04](#), "Pozzolans (Fly Ash)," shall be used to a minimum of 20 percent and a maximum of 35 percent, by weight, of the required Portland cement in concrete, or as required by the Engineer.
1. The replacement of cement with pozzolan shall be at a rate of 1 pound of pozzolan for each pound of Portland cement.
 2. Silica fume may be used to replace 3 percent to 7 percent, by weight, of the total cementitious material.
 3. Store pozzolan in separate weather-tight facilities.

501.02.04 CONCRETE MAKING PROPERTIES

- A. The mix design procedure shall comply with the method indicated on the IQAC website (see Subsection [501.01.02](#), "Quality Control Testing and Inspection"). The type of cement permitted, the minimum sacks of cement required, and the maximum water/cement ratio shall be as shown in Table 1.

Table 1 - Cements Permitted, Sack Requirements, and W/C Ratio		
Type of Cement Permitted	Minimum Sacks of Cement Per Cubic Yard ³	Maximum Water/Cement Ratio
Type II & Fly Ash	6.5 ^{2, 3}	0.45
Type MS & Fly Ash	6.5 ^{1, 2}	0.45
Type 1-P (MS)	6.5	0.45
Type V	6.5 ³	0.45
Type HS	6.5 ²	0.45
Type V & Fly Ash	6.0 ^{2, 3}	0.45
Type HS & Fly Ash	6.0 ^{1, 3}	0.45

- B. The testing frequency shall comply with the Contracting Agency requirements or the Special Provisions.
- C. Prior to mix design approval, the Contracting Agency reserves the right to verify the mix design test results, using the sources and proportions of materials as indicated by the mix design.
- D. The mix design submittal shall include the information indicated in the concrete design report form on the IQAC website.

501.02.05 ZERO SLUMP CONCRETE FOR THE MANUFACTURING OF PRECAST CONCRETE PRODUCTS

- A. Concrete products manufactured by the zero slump method shall comply with Subsection [501.02.03](#), "Admixtures" and Subsection [501.02.04](#), "Concrete Making Properties." Zero slump concrete shall also exhibit design and performance requirements meeting IQAC and relevant ASTM specifications. Air entrainment is not required in a dry cast manufacturing process.

¹ Maximum of 8 sacks.

² Sacks per cubic yard before replacement with fly ash.

³ 5.0 sacks per cubic yard for precast products, pipe and box, with zero slump mix design.

- B. For zero slump concrete, all other parts of this section do not apply.

501.02.06 LOW SLUMP CONCRETE FOR THE MANUFACTURING OF EXTRUDED SLIP FORM CONCRETE

- A. Extruded slip form concrete shall comply with material requirements contained in Table 1, above, and with design and performance requirements meeting IQAC and relevant ACI specifications. The plastic properties may be adjusted on-site with an appropriate type admixture to ensure compliance with Subsection [501.03.04](#), "Classification and Proportions," and to aid Contractor in placement and finishing of low slump slip form concrete.

501.02.07 SELF-CONSOLIDATING CONCRETE

- A. The Contractor's use of self-consolidating concrete shall require the approval of the Engineer and shall be subject to the following requirements:
1. Substitutions. Class S concrete may be substituted for selected applications for classes A, D, Modified A, and Modified D; and Class SA concrete may be substituted for selected applications for classes AA, DA, PAA, Modified AA, and Modified DA, as approved by the Engineer.
 2. Trial Placement.
 - a. The Contractor shall submit details of a representative test section (mockup) for approval.
 - b. Produce a trial batch of classes S and SA concrete, conforming to the proposed mix design.
 - c. As part of the concrete placement demonstration, provide the labor, equipment, and materials to test the concrete. Evaluate the mixture for strength, air content, slump flow, visual stability index, J-ring value, and hardened visual stability index.
 - d. Place a test section when the atmospheric conditions approximate the conditions anticipated for placing the final work. Finish and cure the mockup according to this section.
 - e. If it is determined that the trial batch is not workable or not able to be properly placed or finished, modify the mix design or batching sequence. Submit the revised mix design and batching sequence to the Engineer, and place another test section. Repeat the submittal and trial pour process until a workable and finished trial batch is produced.
 - f. Do not place any Class S and SA concrete until the Engineer accepts the mockup pour.
 - g. A new mix design and a new trial pour will be required whenever there is a change in the source of any component material.
 - h. Segregated concrete, as determined by NV Test Method SCC-2, shall not be incorporated into any component of the anticipated concrete work.
 - i. When a truck mixer or agitator is used for transporting concrete, deliver the concrete to the site of the work and complete discharge within 60 minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, a mixing and

delivery time of less than 60 minutes may be required. A mixing and delivery time exceeding 60 minutes may be approved by the Engineer if a trial pour is performed with satisfactory results.

- j. Place each successive batch within a maximum time interval of 20 minutes. Place the concrete in continuous layers. When it is necessary by reason of emergency or other delay, to place less than a complete horizontal layer in one operation, terminate each layer by using a vertical bulkhead. Do not rod or vibrate the concrete to attempt restoring the fluidity to the mix. Plan and regulate the delivery of concrete so that minor interruptions due to form repair, material testing, etc. will not impact the required 20-minute time interval between successive placements.
- 3. Concrete Slump Requirements. Except for concrete used in drilled shafts, the requirements of NV Test Method T438 will be performed at 2 hours, 3 hours, or for extended times depending on the concrete placement duration.
- 4. Drilled Shafts. Use Class S or SA concrete for drilled shaft construction. Upper portions of drilled shafts (top of shaft down to bottom of embedded vertical column reinforcing) may be constructed using the column concrete mix.

CONSTRUCTION

501.03.01 EQUIPMENT

- A. With the exception of items indicated in Subsection [501.03.05](#), "Proportioning Methods," and Subsection [501.03.06](#), "Machine Mixing," the measurement of materials and batching shall comply to the ACI 304, Chapters 3 and 4 recommendations and those in this section or as approved by the Engineer.
 - 1. Certify concrete production facilities and delivery equipment by complying with National Ready-Mix Concrete Association certification requirements.
 - 2. Methods employed in performing the work and all equipment, tools, and machinery used for handling materials and executing any part of the work shall be subject to the approval of the Engineer.
 - 3. All equipment necessary shall be on hand and approved before concrete operations are begun by the Contractor.
- B. Provide adequate internal vibrating equipment, including power, to enable the Engineer to fabricate concrete cylinders for testing purposes.
- C. Furnish internal vibrators with rigid or flexible shafts, preferably powered by electric motors, capable of operating at a frequency of 7,000 vibrations per minute or greater.
 - 1. The outside diameter or the side dimensions of the vibrating element shall be at least 3/4 inch and not greater than 1-1/2 inches.
 - 2. The length of the shaft shall be at least 24 inches.
- D. The Contractor shall maintain the equipment in good condition and adjustment. Concrete mixers and other equipment which are not adequate or suitable for the work shall be removed and suitable equipment shall be provided by the Contractor.

501.03.02 PROTECTING AND SAMPLING CEMENT

- A. Suitable means of storing and protecting the cement against moisture or other injurious effects shall be provided by the Contractor. Sacked or bulk cement which, for any reason, has become partially set or which contains lumps of caked cement shall be rejected and shall be immediately removed from the worksite.
- B. Different brands of cement shall not be mixed during use or in storage, nor shall different brands be used alternately in any one structure. The same brand and kind of cement shall be used in a given structure above the ground line. A change in brand of cement will require a new mix design.
- C. The sacked cement shall be so piled as to permit access for tally, inspection, and identification of each shipment.
- D. The Contractor shall obtain from the cement company from which the cement is purchased, a certificate stating that the cement delivered to the work complies with the specifications for the type of cement specified for use, with tests pertaining to the delivered lot. The certificate shall be dated, signed, and indicate the quantity of shipment. Two copies shall be delivered directly to the Engineer.
- E. Upon receipt of the certificate of compliance, the Engineer may permit the use of the cement. When a certificate of compliance is not furnished to the Engineer, the cement shall not be used in the work until a release for its use has been received by the Contractor from the Engineer.
- F. Whenever it is determined by a laboratory test of mill or field samples that the cement does not comply with the specifications, the use of that cement will be suspended until tests by a third party paid for by the Contractor can be made and the test results are approved by the Engineer.
- G. All cement not conforming to the specifications and all cement damaged by exposure to moisture shall be removed immediately and permanently from the work.

501.03.03 STORAGE OF AGGREGATES

- A. Refer to ACI 304, Chapter 2.2.3. The handling and storage of aggregates shall be such as to prevent segregation or contamination by foreign materials.
- B. Maintain aggregate stockpiles in saturated surface dry condition.
- C. In placing materials in storage or in moving materials from storage to the mixer, any method which may cause the segregation, degradation, or the combining of material of different gradings which will result in any stockpile or bunker material failing to meet specified requirements shall be discontinued and the materials shall be reprocessed or wasted.

501.03.04 CLASSIFICATION AND PROPORTIONS

- A. For non-commercial sources, the Contractor shall notify the Engineer not less than 30 calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.
 - 1. The sources of materials to be used on a project shall not be changed during the job except with the written consent of the Engineer.
 - 2. If permission to change sources of material is granted, a new job mix formula shall be required.
 - 3. Samples shall not exceed 500 pounds for each separate grading.

- B. When requested by the Contractor, exceptions to the above requirement may be granted in writing by the Engineer under either of the following conditions:
1. The concrete structures on the project are minor in nature, such as culvert headwalls, manholes, small boxes, sidewalks, etc., generally, when less than 100 cubic yards of concrete are called for on the project.
 2. When the aggregate source has been previously tested within the past 1 year and accepted by the Contracting Agency.
- C. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions. In the case of Class EA concrete, no changes will be allowed without new laboratory trial testing and subsequent approval.
- D. Batches of concrete shall not vary more than ± 3 pounds per cubic foot in unit weight from design mix. The cement factor of any individual batch placed in the work shall not be more than 14 pounds per cubic yard less, nor more than 23 pounds per cubic yard greater than the designated cement factor. Batch aggregates and report by weight to the Engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.
- E. For Class EA Concrete, Modified, perform laboratory trial tests to determine strength and compatibility of all materials (as specified in Table 2 of this subsection and in Subsection [501.02.03](#), "Admixtures") to be used. Contractor shall have an approved laboratory perform the tests and furnish documentation of such tests. Laboratory trial batches may be observed by the Engineer.

Table 2 - Concrete Mix Designation ^{4, 5}							
Class of Concrete	Cementitious Range lb/yd ³	Max. Nom. Coarse Aggregate Size inches	Min. 28-Day Compressive Strength ⁶ psi	Slump Range inches	Entrained Air Range %	Unit Weight Variation lb/ft ³	Use
A	564-705	1-1/2	3000	1-4	4-7	± 3	General use and reinforced structures
AA	564-705						
B	517-705	2	3000	1-5	4-7	± 3	Massive or lightly reinforced sections
BA				1-4			
C	470-611	2-1/2	2500	1-5	4-7	± 3	Massive unreinforced and backfill
CA	517-658						
D	564-705	3/4	3000	1-4	4-7	± 3	Thin reinforced sections, hand rails, etc.
DA	564-752						
PA A	564-752	3/4	Specified on Plans	1-4	Specified on Plans	± 3	Prestressed members

⁴ Blend the coarse aggregate gradation from stockpiles conforming to the requirements of Subsection [706.03.01](#), "Coarse Aggregate," and the stated nominal maximum size. Submit test reports for trial batches showing each stockpile sieve size and the proportions used for blending. Adhere to Subsection [706.02.01](#), "General," for the combined gradation regardless of coarse aggregate gradation. If approved, coarse aggregate nominal maximum size of 1 inch may be used in lieu of 3/4 inch.

⁵ Air entrainment on mixes placed above 6000 feet elevation

⁶ Comply with Subsection [501.02.04](#), "Concrete Making Properties," of the NDOT Standard Specifications for the moving average method of evaluating concrete specified under Statistical Evaluation of Concrete Strength.

Table 2 - Concrete Mix Designation^{4, 5}							
Class of Concrete	Cementitious Range lb/yd³	Max. Nom. Coarse Aggregate Size inches	Min. 28-Day Compressive Strength⁶ psi	Slump Range inches	Entrained Air Range %	Unit Weight Variation lb/ft³	Use
Modified A and AA	564-752	1-1/2	Specified on Plans	1-4	4-7 (AA only)	± 3	Where specified on plans
Modified D and DA	564-752	3/4	Specified on Plans	1-4 ⁷	4-7 (DA only)	± 3	Where specified on plans
Modified EA ⁸	564-752	3/4	Specified on Plans	1/2 -4	4-7	± 3	High Performance Concrete
S and SA	639-925 ⁹	3/4 ¹⁰	Specified on Plans	N/A	4-7 (SA only) ¹¹	± 3	Self Consolidating Concrete

501.03.05 PROPORTIONING METHODS

- A. Except as hereinafter noted, aggregate bins shall conform to either 1 or 2 as follows:
- Each specified size of aggregates shall be stored in a separate bin. Except as hereinafter specified, each bin shall be provided with an individual outlet gate, designed and constructed to prevent leakage when closed. The gates shall cut off quickly and completely.
 - Each size aggregate shall be weighed individually in a single bin, providing there is a satisfactory method employed to eliminate any excess material resulting from over-charging of the bin before the material reaches the surge hopper.
- B. Conformance to 1 and 2 above will not be required when batching for culvert headwalls, manholes, small boxes, sidewalks, etc., and the total quantity of concrete called for on the project does not exceed 300 cubic yards.
- C. All aggregates for use in Portland cement concrete shall be proportioned by weight, with the exception that aggregates for culvert headwalls, short pieces of curb and gutter, or small sections of sidewalk and related minor work may be proportioned either by weight or volume as the Contractor may elect. Measuring boxes of known capacity shall be furnished and used to measure each size of aggregate proportioned by volume.
- D. Water shall be proportioned to maintain batching consistency with regard to stockpile moisture contents and varying absorption values for both coarse and fine aggregates. The Engineer may request the Contractor to submit a new mix design if either the coarse or fine aggregate absorption values vary from the approved mix design by more than 1 percent.
- E. Bulk cement shall be weighed separately when the batch is 1 cubic yard or more.

⁷ For extruding barrier or bridge rail, slump range is 0.5-4 inches.

⁸ Aggregates shall consist of a blend of coarse, intermediate, and fine aggregates in order to produce a dense grading. Consideration of the grading, workability factor, and coarseness factor, as outlined in ACI 302 shall be utilized. The aggregate maximum nominal size shall consist of at least a nominal 3/4 inch stone size.

⁹ The maximum shrinkage requirement of 0.06% in 28 days air dry after 28-day wet cure, ASTM C157, shall apply if the total cementitious material exceeds 752 pounds per cubic yard.

¹⁰ If approved, 1/2 inch or 3/8 inch may be used in lieu of 3/4 inch.

¹¹ Air content shall be as follows: For 1/2 inch max. aggregate size, 4.5% - 7.5%, and for 3/8 inch max. aggregate size, 5% - 8%.

1. The scale and weigh hopper for the cement shall be separate and cement hopper shall be interlocked against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is underweight by more than 1 percent of the amount specified.
 2. An interlock system will not be required on projects having less than 300 cubic yards in the bid schedule.
- F. Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.
- G. If of the dial type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.
- H. If of the multiple beam type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or under weight.
1. The indicator shall be so designed that it will operate during the addition of the last 400 pounds of any weighing.
 2. The over travel of the indicator hand shall be at least 1/3 of the loading travel.
 3. The indicator shall be enclosed against moisture and dust.
- I. Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading and cutoff shall not vary from the weight designated by more than 1 percent for cement and 1-1/2 percent for any size aggregate, nor 1-1/2 percent for the total aggregate in any batch.
- J. Scales shall be approved with a certificate of inspection as required by Subsection [109.01](#), "Measurement of Quantities."
- K. When the entire plant is running, the scale reading and cutoff weights shall not vary from the mix design by more than 1 percent for cement, fly ash, and silica fume, 1.5 percent for any individual size aggregate, and 1 percent for the total combined aggregate in any batch. The total water shall not exceed the maximum water specified in the mix design.
- L. Should separate supplies of aggregate and material of the same size group, but of different moisture content or specific gravity be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the material therein completely exhausted before starting upon another.
- M. Stockpiled aggregates shall be in a saturated surface dry condition just prior to batching.
1. The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the proportioning plant to the point of mixing.
 2. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dried to meet the above requirements.
- N. Batches with cement in contact with damp aggregates shall be mixed within 30 minutes after being proportioned. Batch trucks hauling more than 1 batch of cement and aggregate shall be so constructed that materials do not flow from one compartment to another during haul or discharge.

- O. Coarse and fine aggregate shall be handled and measured separately. Cement shall be emptied directly into the charging skip of the mixer. Water shall be measured either by volume or by weight.
- P. The equipment for measuring and supplying the water to the mixer shall be so constructed and arranged that the amount of water added to the mixture can be measured in one operation into the mixing drum without dribbling.
 - 1. The equipment shall be so designed that water from the source of supply cannot enter the measuring tank while the water is being discharged from the measuring tank into the mixer.
 - 2. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than 1 percent from the required quantity of water for any position of the mixer with respect to a level plane.
 - 3. The tanks or other equipment shall be so arranged as to permit the checking of the amount of water delivered by discharging into measured containers.

501.03.06 MACHINE MIXING

- A. Concrete manufactured by any procedure which results in any unmixed lumps of cement in the mixed product shall be rejected. The preparation of the mix shall be in accordance to ACI 318, Section 5.8, "Mixing," and this section. The Cement and Concrete terminology is defined in ACI 116.
- B. The Engineer shall be provided with a legible ticket with each load of concrete delivered to the project site which shall contain the following information:
 - 1. Name of Vendor.
 - 2. Name of Contractor.
 - 3. Number of Cubic Yards in the Load.
 - 4. Actual Weights of Cement and of each Size of Aggregate.
 - 5. Amount of Water Added at the Plant.
 - 6. Amount of Water in the Aggregate.
 - 7. Brand and Type of Cement.
 - 8. Brand and Amount of Admixture.
 - 9. Time and Date of Batching.
- C. Space shall be provided on the ticket so the amount of water added on the job may be indicated.
- D. All concrete shall be mixed in mechanical mixers, except that when permitted by the Engineer, batches not exceeding 1/3 cubic yard may be mixed by hand methods in accordance with the provisions of Subsection [501.03.07](#), "Hand Mixing."
 - 1. Mixers shall have legible permanently attached plates showing manufacturer's rated capacity, mixing speeds, and serial number.
 - 2. Mixers may be stationary mixers or truck mixers.
 - a. Agitators may be truck mixers operating at agitating speed or truck agitators.

- b. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete, and the speed of rotation of the mixing drum or blades.
3. The Contractor, at no additional cost to the Contracting Agency, shall furnish samples of the fresh concrete and provide safe and satisfactory facilities for obtaining the samples.
4. Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer.
5. The temperature of materials as charged into the mixer shall be such that the temperature of the mixed concrete at the time it is placed in final position is not less than 50 degrees F nor more than 90 degrees F as specified in Subsection [501.03.10.B](#), "Cold Weather – General," and Subsection [501.03.10.C](#), "Low Temperature Protection." Aggregates and water used for mixing shall not exceed 150 degrees F.
6. Concrete for structures shall be mixed for a period of not less than 60 seconds nor more than 5 minutes after all materials, including water, are in the mixer.
7. Cement shall be batched and charged into the mixer by means that will not result either in loss of cement due to the effect of wind, or an accumulation of cement on surfaces of conveyors or hoppers, or in other conditions which may vary the required quantity of cement in the concrete mixture.
8. Stationary mixers having a capacity of 1 cubic yard or more and all paving mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanisms shall be so interlocked that during normal operations no part of the batch will be discharged until the specified mixing time has elapsed.
9. The total elapsed time between the intermingling of damp aggregates and cement and the start of mixing shall not exceed 30 minutes.
10. Mixers and agitators which have an accumulation of hard concrete or mortar or worn blades shall not be used.
11. When central-mixed concrete is furnished and non-agitating hauling equipment is used for transporting concrete to the delivery point for Portland cement concrete pavement, discharge into the laydown machine shall be completed within 45 minutes after the addition of the cement to the aggregates.

E. Ready-Mixed Concrete.

1. Ready-mixed concrete shall be central-mixed, shrink-mixed, or transit-mixed concrete. Shrink-mixed concrete is that which has been mixed partially in a stationary mixer and the mixing completed in a truck mixer.
2. The size of batch in truck mixers and truck agitators shall not exceed the rated capacity as determined by the current Standard Requirements of Truck Mixer Manufacturers Bureau. The size of batch in stationary mixers shall not exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America. No batches requiring fractional sacks

of cement will be permitted unless all of the cement is weighed when added to the batch.

3. If the use of ready-mixed concrete is approved, the producers shall use only that cement approved by the Contracting Agency for use on the project. Contracting Agency approved cement shall be stored at the concrete plant in such a manner that it can be identified and kept separate from other cement.
4. Ready-mixed concrete for structures shall be transported in truck mixers or truck agitators.
5. The mixer, when loaded to capacity, shall be capable of combining the ingredients of the concrete within the specified time, into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. The agitator, when loaded to capacity, shall be capable of maintaining the mixed concrete in a thoroughly mixed uniform mass and of discharging the concrete with a satisfactory degree of uniformity.
6. Mixers and agitators shall be examined periodically for changes in condition due to accumulation of hardened concrete or mortar or to wear of the blades.
 - a. When any such change in condition is found, the concrete shall be subjected to the slump tests.
 - b. If the tests indicate that the concrete is not being properly mixed, the faulty equipment shall be corrected before its further use is allowed.
7. Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may be readily verified. The counters shall be of the continuous-registering, non-resettable type, which accurately register the number of revolutions, and shall be mounted on the truck mixer so that the Engineer may safely and conveniently inspect them from alongside the truck.
8. When a truck mixer is used, each batch of concrete shall be mixed for not less than 70 and no more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed designated by the manufacturer of the equipment as agitating speed.
9. When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed shall be allowed for partial mixing in a central plant.
10. No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless permitted by the Engineer. If the Engineer permits additional water to be incorporated into the concrete, the drum shall be revolved not less than 30 revolutions at mixing speed after the water is added and before discharge is commenced.
11. The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of revolution of the drum in the discharge direction with the discharge gate fully open.
12. When truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the

speed designated by the manufacturer of the equipment as agitating speed. Do not exceed a total of 300 revolutions from the time of initial batching to complete discharge of delivered concrete.

13. When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within 90 minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete as determined by the Engineer, a delivery time of less than 90 minutes may be required. When a truck mixer is used for the complete mixing of the concrete, the mixing operations shall begin within 30 minutes after the cement has been intermingled with the aggregate.
14. If the mixing plant is such a distance from the site of the work that it is not practical to have the mixed concrete delivered and placed in forms within the time limit specified, cement and water shall not be added until such time as requirements can be complied with.
15. The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to ensure continuous delivery at the rate required.
 - a. The rate of delivery of concrete shall be used as to provide for the proper handling and placing of concrete.
 - b. An interval of more than 45 minutes between any 2 consecutive batches or loads, or a delivery and placing rate of less than 8 cubic yards of concrete per hour shall constitute cause of shutting down work for the remainder of the day, and if so ordered by the Engineer, the Contractor shall make, at no additional cost to the Contracting Agency, a construction joint at the location and of the type directed by the Engineer in the concrete already mixed.
16. After mixing of ready-mixed concrete has been completed, it shall be agitated continuously at agitating speed until it has been discharged from the drum.
17. Wash water shall be completely discharged from the drum or mixing container before the succeeding batch is introduced. Cement balling (intermittent clumping) and mix foaming shall be prevented by controlling the batch sequence, mixing speed, and mixing time.
 - a. When intermittent clumping exceeds 1-2 clumps per yard or 10 clumps per truck, the entire load will be rejected.
 - b. The clumps shall not exceed 5 inches in diameter.

501.03.07 HAND MIXING

- A. Hand mixing shall not be permitted, except in case of an emergency or under written permission of the Engineer.
- B. When permitted, hand mixing shall be done only on watertight platforms.
 1. The sand shall be spread evenly over the platform and the cement spread upon it.
 2. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of uniform color, after which it shall be formed into a "crater" and water added in the amount necessary to produce mortar of the proper consistency.

3. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced.
 4. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least 6 times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance.
- C. Hand mixing will not be permitted for concrete to be placed under water.
- D. Preproportioned sack concrete may be used for grout caps or other nonstructural uses as approved by the Engineer.

501.03.08 RETEMPERING

- A. Concrete shall be mixed only in such quantities as are required for immediate use and shall be placed before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in the work.
- B. No retempering of concrete shall be allowed.

501.03.09 CURING

- A. Comply with ACI 308, Standard Specification for Curing Concrete, with the following exceptions or additions:
1. **General.** All concrete shall be cured for the length of time hereinafter specified. If Type III cement is used, the curing time may be reduced as directed by the Engineer. In the event of low temperatures, the time will be increased according to the procedures specified in Subsection [501.03.10.B](#), "Cold Weather – General."
 - a. Cure all bridge decks and approach slabs according to Subsection [501.03.09.A.6](#), "Bridge Deck Curing."
 - b. Curing shall commence immediately upon completion of the finish. In the event that the application or placement of the curing medium is delayed, curing will be as described under 2 below.
 2. **Water Method.** The concrete shall be kept continuously wet by the application of water for a minimum period of 7 days after the concrete has been placed.
 - a. Use fogging equipment capable of applying water through an atomizing nozzle in the form of a fine mist, not a spray. The equipment may use water pumped under adequate high pressure, or a combination of air and water pumped under high pressure. Use equipment sufficiently portable for use in the direction of any prevailing wind. Adapt equipment for intermittent use as directed to prevent excessive wetting of the concrete.
 - b. Cotton mats, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period. The cotton mats, rugs, or carpets shall be of such character that they will retain water.
 3. **Curing Compound Method.** The entire surface of the concrete shall be sprayed uniformly with a curing compound. It shall be applied when just a light film of water is present on the surface. If the surface is dry, water shall be added as specified in 2 above before the curing compound is applied.

- a. On decks or slabs cured by this method, foot traffic shall be held to a minimum and these surfaces shall not be used as a work area during the cure period. Should the film of the compound be damaged before the expiration of 7 days, the damaged portions shall be repaired immediately with additional compound.
- b. Uniformly spray the entire surface of the concrete with a curing compound conforming to Subsection [702.03.01](#), "Curing Materials," except as hereinafter specified for concrete bridge decks that are to be the roadway surface. The curing compound shall be applied to the exposed surface at a uniform minimal rate of 1 gallon per 150 square feet of area.
- c. Do not apply the curing compound until all patching and surface finishing, except grinding, have been completed. When ordered during periods of hot weather, continue fogging of the concrete with water after curing compound is applied until no longer required. Such fogging after the application of the curing compound will be paid for as extra work as provided in Subsection [104.03](#), "Extra Work."
- d. The curing compound shall be delivered to the work in ready-mixed form. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. The compound shall not be diluted or altered in any manner, unless dilution is recommended by the manufacturer.
- e. Provide curing compounds which remain sprayable at temperatures above 40 degrees F and do not hard settle in storage.
- f. Curing compound that has become chilled to such an extent that it is too viscous for satisfactory application shall be warmed to a temperature not exceeding 100 degrees F
- g. Curing compound shall be packaged in clean 55-gallon steel barrels or round 5-gallon steel containers or supplied from a suitable storage tank located at the jobsite.
 - 1) Each 55-gallon barrel shall be equipped with a built-in agitator having 2 sets of blades, one at the bottom and one midway between top and bottom, and with removable lids and airtight band fasteners.
 - 2) On-site storage tanks shall be kept clean and free of all contaminants. Each tank shall be provided with a permanent system designed to completely redisperse any settled material without introducing air or any other foreign substance.
 - 3) Barrels shall be filled in a manner that will prevent skinning.
 - 4) Ring seals and lug type crimp lids shall be used to seal 5-gallon containers well.
 - 5) Containers shall be provided with lining that will resist the solvent of the curing compound and will not permit skins to be loosened into the body of the curing compound.
 - 6) Each container shall be labeled with the manufacturer's name, batch number, type of compound, number of gallons, and date of manufacture. Each container shall also be labeled with an Interstate Commerce Commission Red Label warning concerning flammability.

The label shall also warn that the curing compound shall be well stirred before use.

- 7) When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall be supplied with each load containing the same information as that required herein for container labels.
 - h. Curing compound may be sampled by the Engineer at the source of supply, at the job site, or at both locations.
 - i. Curing compound not used within 6 months of the date of manufacture will require certification from the manufacturer that the curing compound still conforms to ASTM C309. Curing compound more than 1 year old or without a manufacture date on the container will not be allowed for use.
4. Waterproof Membrane.
- a. Keep the exposed finished surfaces of concrete damp with water using an atomizing nozzle, as specified in Subsection [501.03.09.A.2](#), until the concrete has set.
 - b. Place the curing membrane after the concrete has set.
 - 1) The membrane shall be formed into sheets of such width as to provide a complete cover of the entire concrete surface.
 - 2) All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint.
 - 3) Overlap of sheets shall have a minimum lap of 18 inches.
 - 4) The sheets shall be securely weighted down by placing a bank of earth on the edges of sheets or by other means satisfactory to the Engineer.
 - 5) Sheeting material shall conform to Subsection [702.03.01](#), "Curing Materials."
 - c. The curing membrane shall remain in place for a period of not less than 7 days.
 - d. Should any portion of the sheets be broken or damaged before the expiration of the curing period, the broken or damaged portion shall be immediately repaired with new sheets properly cemented into place, or water curing as described above shall commence immediately.
 - e. Sections of the membrane which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing shall not be used.
5. Form Method.
- a. If forms are kept on the concrete surfaces, this will be considered adequate cure for these surfaces.
 - b. However, should the forms be removed within 7 days after the concrete has been placed, one of the above methods shall be used on the exposed surfaces.
 - c. Comply with Subsection [502.03.11](#), "Removal of Falsework and Forms."
6. Bridge Deck Curing.

- a. Submit a quality control plan for concrete placement and curing, for review and approval, a minimum of 30 days prior to the pre-pour conference for bridge decks and approach slabs. The plan shall include, but not be limited to, information on the procedures for when and how the concrete and the curing system is to be placed, frequency for monitoring, maintaining, and re-wetting the curing system chosen, and a list of personnel responsible for performing such work. Include in the plan, equipment to be used for placement of concrete and the curing system, methods of protecting the covers from displacement from wind or weather, and methods of preventing loss of heat and moisture.
- b. Describe procedures to be followed in the event of equipment breakdown or inclement weather during concrete placement. In addition, describe the method to be used to protect pedestrian and vehicular traffic under the structure.
- c. Use Figure 2.1.5 from ACI 305R, Hot Weather Concreting, to determine the evaporation rate. Additional protection measures shall be provided if the rate of evaporation exceeds 0.1 pound per square foot per hour.
 - 1) Accurate record of placement location, air temperature, relative humidity, concrete temperature, and wind velocity shall be provided.
 - 2) Readings shall be taken an hour prior to the concrete placement and at 1-hour increments during concrete placement, until the final curing blanket is placed.
 - 3) Required data shall be submitted to the Engineer.
- d. Concrete temperature shall be monitored during the entire curing period by utilizing recording thermocouples embedded at 1 inch below the concrete surface and 1 inch above the bottom concrete surface.
 - 1) A minimum of 2 sets of thermocouple installations will be required per each day's placement.
 - 2) The thermocouple shall be capable of recording the concrete temperature as a function of time.
 - 3) Acceptable devices include thermocouples connected to electronic data loggers.
 - 4) The recording time intervals shall be a maximum of 30 minutes.
 - 5) The recording devices shall be accurate to within ± 1.8 degrees F. Concrete temperature between the top and bottom of the slabs and the supporting girders shall be maintained to a maximum differential temperature of 30 degrees F.
 - 6) If differential temperatures exceed the requirements, measures shall be taken to correct the curing process.
 - 7) Required data shall be submitted to the Engineer.
- e. Immediately after the concrete is placed, the moisture content shall be maintained by humidifying the air directly above the concrete surface until the curing covers are placed. Fogging equipment described in

Subsection [501.03.09.A.2](#), "Water Method," shall be used, mounted on a finishing bridge that is separate from the concrete placing equipment.

- f. Begin placing pre-soaked burlap within 30 minutes after finishing has started. Wet curing of the surface shall be performed for 10 days, unless otherwise directed, with the following covering:
 - 1) Burlap and Polyethylene Covering. Burlap conforming to Subsection [702.03.01](#), "Curing Materials," and polyethylene (white or reflective) conforming to ASTM C171 shall be furnished. Soaker hose shall be placed or other approved method shall be used to provide continuous wetting of burlap between the burlap and polyethylene covering.
 - g. Pre-wetted curing coverings shall be placed with a finishing bridge. Covers shall be placed directly behind the concrete fogging operation.
 - h. The covering shall be maintained uniformly wet during the entire curing period. Provide 24-hour monitoring of the wet curing for the full length of the curing period. Water temperature shall not be more or less than 20 degrees F from the temperature of top of bridge deck.
 - i. Covers shall be lapped a minimum of 18 inches. All lapped edges shall be sealed to prevent loss of heat and moisture.
 - j. If the ambient temperature drops below 45 degrees F during the first 4 days of curing, additional protection shall be provided according to Subsection [501.03.10.C](#), "Low Temperature Protection."
 - k. After completion of wet curing and removal of curing covering, immediately remove excess water and apply an application of curing compound according to Subsection [501.03.09.A.3](#), "Curing Compound Method."
 - l. All cracks on new bridge decks and approach slabs shall be repaired. Requested method of repair shall be submitted for approval.
7. Maturity Meter Method:
- a. This method may be used if referred to in the Contract Special Provisions.
 - b. The method specified in ASTM C1074 may be used in order to reduce the cure time. This method requires training and certification of the Quality Assurance and Control personnel.
 - c. This method shall not be used for acceptance but for reducing the time required for form removal. The Contractor shall have a plan of action approved by the Engineer and monitored by a third party engineer for meter placement and monitoring.

501.03.10 WEATHER LIMITATIONS

- A. **General.** If impending inclement weather conditions exist, the Contractor shall decide whether or not to begin the placement and the Contractor shall have sole responsibility for Contractor's decision.
- 1. Before any concrete is placed, the Contractor shall have adequate provisions readily available as approved by the Engineer, to protect the concrete from any impending weather conditions.

2. In case precipitation should occur after placing operations have started, the Contractor shall provide ample covering to protect the work.
 3. The placing of concrete shall be stopped before the quantity of precipitation is sufficient to cause a flow or to wash the surface.
- B. **Cold Weather – General.** Comply with ACI 306, Cold Weather Concreting, with the following exceptions or additions:
1. All concrete shall be maintained at a temperature of not less than 50 degrees F for 3 days or not less than 40 degrees F for 7 days. The count of time shall commence immediately upon completion of final placement and vibration. The three 50-degree F days need not be consecutive.
 2. One 24-hour period shall constitute 1 day.
 3. The temperature of the concrete shall be determined by placement of thermometers on the concrete surfaces and properly insulating these devices to record the surface temperature of the concrete.
 - a. Temperature shall be monitored continuously throughout the total protection time required by this subsection.
 - b. In case the surface temperature of the concrete falls below 40 degrees F for a duration of 3 hours or more in any 24-hour period during the time of temperature protection, the time shall be increased 1 day for each day this occurs.
 - c. An absolute minimum temperature of 35 degrees F shall be maintained for the total time of protection specified in this subsection.
 - d. Should the temperature of the concrete fall below 35 degrees F at any time, damage may occur.
 - e. The assessment of damage will be determined by a professional engineer registered in Nevada and paid for by the Contractor and concrete so damaged may require repair or replacement at the option of the Engineer.
 4. The concrete shall have a temperature of at least 50 degrees F and not more than 90 degrees F at the time of placing. (Also, comply with temperature constraints specified in Subsection [501.03.06](#), "Machine Mixing.")
 - a. Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used.
 - b. The equipment shall be capable of heating the materials uniformly.
 - c. Aggregates and water used for mixing shall not be heated to a temperature exceeding 150 degrees F.
 - d. Concrete containing frost or lumps at the time of placing shall not be used.
 5. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire.
 6. Reinforcing steel shall be free of ice, snow, and frost during placement of concrete. Concrete shall not be placed on frozen ground.
- C. **Low Temperature Protection.** Refer to guidelines in ACI 306, Cold Weather Concreting, with the following exceptions or additions:

1. **General.** After the concrete has been placed, means shall be taken to protect the concrete from any impending low temperatures.
 - a. Methods and materials not hereinafter prescribed may be used if approved by the Engineer and the following requirements adhered to:
 - 1) Materials shall be fire resistant
 - 2) Materials shall be waterproof
 - 3) Materials shall not adhere, abrade or damage the surface of the concrete.
 - b. Approval of the Engineer shall not relieve the Contractor from obtaining specification results.
2. **Insulating Blankets.**
 - a. Insulating blankets used to protect concrete from low temperatures shall be fire resistant and waterproof.
 - b. The blankets shall be secured and overlapped along the edges and joints to ensure that no opening will exist in the protection during high winds or other adverse conditions.
 - c. Provisions shall be made to allow the reading of thermometers placed inside of the protection.
 - d. When depositing concrete against previously cast concrete, the blanket insulation shall extend at least 14 inches onto the existing concrete and shall be securely held in place.
3. **Low Temperatures Protection – Heating and Housing.**
 - a. In order to meet the provisions of Subsection [501.03.09](#), paragraphs A and B, the concrete may be protected by applying artificial heat within an enclosure.
 - b. The enclosure shall be constructed with fire resistant material, unless otherwise directed by the Engineer, and shall be subject to Engineer's approval.
 - c. The heating system shall be so arranged as to provide uniform heating, ensuring that the concrete farthest from the source of heat is receiving adequate protection without drying the concrete near the source of heat so as to cause shrinkage cracks.
4. The temperature of the concrete will be determined by placement of thermometers on the concrete surfaces and properly insulating these devices to record the surface temperature of the concrete according to NV Test Method T440.
 - a. Temperature will be monitored continuously throughout the total projection time required by this subsection.
 - b. If the surface temperature of the concrete falls below 50 degrees F during the first 3 days and 40 degrees F during the next 4 days of the temperature protection for a duration of 3 hours, the curing time will be increased 1 day for each day this occurs.
 - c. Should the temperature of the concrete fall below 35 degrees F at any time during the 7 days of temperature protection or if the surface temperature of the concrete falls below 40 degrees F during the first 24 hours of temperature

protection period, the assessment of damage will be determined by a Nevada registered professional engineer paid for by the Contractor and damaged concrete shall be repaired or replaced at the option of the Engineer.

- d. Contractor shall be responsible for all costs associated with damage assessment and repair.

D. **Hot Weather.** Comply with guidelines in ACI 305, Hot Weather Concreting, with the following exceptions or additions:

1. The maximum temperature of cast-in-place concrete shall not exceed 90 degrees F immediately before placement.
2. For continuous placement of concrete on the deck with reinforcing steel units, retard the initial set of the concrete sufficiently to ensure that concrete remains plastic for subsequent placement.
3. For both simple and continuous spans, submit a retardation schedule for approval.
4. The consistency of the concrete as placed shall allow the completion of initial finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for initial finishing, the required water shall be applied to the surface fog spray only, and shall be held to a minimum amount. Apply fog spray for this purpose as specified in Subsection [501.03.09.A.2](#), "Water Method." Fog spray for this purpose may be applied with hand-operated fog equipment, as approved by the Engineer.
5. From the time of initial strike-off until final finish is complete, the unformed surfaces of slab concrete shall be protected from rapid evaporation of mixing water from the concrete due to wind, high temperature, low humidity, or combination thereof.
6. Equipment for fogging, type of evaporation retarder, and method of application shall be approved by the Engineer. Equipment shall be portable, adapted for intermittent use, and operable in the direction of any prevailing wind.
7. Use fogging equipment capable of providing a fog mist, as necessary, to the area between the finishing machine and the tining machine. The fogging equipment shall meet the requirements of Subsection [501.03.09.A.2](#), "Water Method." If at any time it becomes apparent that the combination of fogging and curing application are not, or will not be effective in preventing plastic shrinkage cracking, stop the concrete placement until environmental conditions improve substantially, or until other preventative measures are approved in writing by the Engineer.
8. After all finishing operations are complete a final curing membrane shall be applied.

501.03.11 TRIAL SLAB AND PROCESS CONTROL TESTING

- A. If silica fume is used in bridge deck concrete, construct a trial slab at least 30 days prior to placement of concrete on a bridge deck. Submit a written plan for the casting of decks. Include in this plan, at a minimum, the location of slab, the equipment and personnel used for construction, and disposal of slab. Prior to placement of the trial slab, conduct a Pre-Activity Meeting.
- B. Use approved mix designs. Place concrete at a location other than the bridge deck, but under similar conditions to those that exist during bridge deck concrete placement.
 1. The trial slab shall have a minimum length and width of 50 feet and a depth of 8 inches.

2. Reinforce slab with a top and bottom mat of No. 5 bars spaced 6 inches longitudinally and transversely.
 3. Place top mat at a depth of 2-1/2 inches from the top of the slab.
 4. Place bottom mat at a depth 1-1/2 inches from the bottom of slab.
 5. The trial slab shall be wet-cured in accordance with the specifications.
 6. Use personnel such as superintendent, key operators, and finishers that are the same personnel who will be involved in the final construction of the bridge deck.
 7. Demonstrate the use of equipment, proficiency of personnel, and techniques for mixing, transporting, placing, and curing of the concrete during the trial.
 8. Fifteen days after the placement of the trial slabs, conduct a post construction critique of the trial slab placement in writing.
- C. Do not commence placement of bridge deck concrete until after any issues from the post construction critique of trial slab construction have been resolved to satisfaction of the Engineer.
- D. Upon notification, remove and dispose of trial slabs according to Subsection [107.14](#), "Disposal of Material Outside Project Right-of-Way."

501.03.12 MORTAR

- A. Cement mortar shall consist of a mixture of Portland cement, sand, and water. Cement and sand shall first be combined in the proper proportions, and then thoroughly mixed with the required amount of water.
1. Cement mortar shall be designated by class and proportioned by loose volume as follows:

Table 3 - Mortar Proportioning	
Designation	Proportions
Class "A" Mortar	1 Part Cement to 1 Part Sand
Class "B" Mortar	1 Part Cement to 1-1/2 Parts Sand
Class "C" Mortar	1 Part Cement to 2 Parts Sand
Class "D" Mortar	1 Part Cement to 2-1/2 Parts Sand
Class "E" Mortar	1 Part Cement to 3 Parts Sand
Class "F" Mortar	1 Part Cement to 3-1/2 Parts Sand

2. The quantity of water to be used in the preparation of mortar shall be only that required to produce a mixture sufficiently workable for the purpose intended.
 3. Mortar shall be used as soon as possible after mixing and shall show no visible signs of setting prior to use. Re-tempering of mortar will not be permitted.
- B. **Cement.** Cement shall conform to the requirements of Section [701](#), "Hydraulic Cement."
- C. **Sand.** Sand shall conform to the requirements of Subsection [706.03.04](#), "Grout and Mortar Sand." In proportioning the sand it shall be measured loose (without shaking or compacting) in measuring boxes or other suitable containers of known capacity.
- D. **Admixtures.** No admixture shall be used in mortar unless otherwise specified or approved by the Engineer.

METHOD OF MEASUREMENT

501.04.01 MEASUREMENT

- A. Portland cement concrete will be measured for payment in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

BASIS OF PAYMENT

501.05.01 PAYMENT

- A. Portland cement concrete shall be paid for in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

501.05.02 TRIAL SLAB PAYMENT

- A. Full compensation for construction and removal of trial slabs and trial pours shall be considered as included in the contract unit price paid for other appropriate items and no separate payment will be made therefor.

SECTION 505

REINFORCING STEEL

DESCRIPTION

505.01.01 GENERAL

- A. This work shall consist of furnishing and placing reinforcing steel and mesh reinforcing in accordance with ACI 318 Chapter 7 and ACI 315 with the additions or exceptions listed below.

MATERIALS

505.02.01 GENERAL

- A. Materials shall conform to the requirements specified in the following subsections:

Materials	Subsection
Fabricated Steel Bar or Rod Mats Reinforcement	713.03.02
Bar Steel Reinforcement	713.03.01
Welded Steel Wire Fabric Reinforcement	713.03.03

- B. Bar steel reinforcement shall be Grade 60 bar steel reinforcement unless otherwise specified on the plans.
- C. Spiral Reinforcement may be either Bar Steel Reinforcement or Steel Wire, of the equivalent size of the bar steel.
- D. Epoxy coatings for steel reinforcing bars shall conform to ASTM D3963. Epoxy coatings listed in the NDOT QPL, found on the web at http://www.nevadadot.com/reports_pubs/qpl/pdfs/QPL.pdf, shall be used.
- E. Tie wire shall be commercial quality 16 gage minimum, black annealed soft iron wire, unless otherwise approved. Tie wires used on epoxy coated reinforcing steel shall be coated with plastic or an equal type coating as approved.

505.02.02 SAMPLES

- A. One extra bar of each diameter shall be furnished for each 100 tons or fraction thereof.
1. This bar shall be selected from the longest bar of each size so that the bar, or a portion of it, can be used to replace any bar of that diameter that is selected to be used as a field sample.
 2. Supplied field sample shall be of sufficient length to provide two 30-inch samples of each diameter.
 3. The extra bars shall be indicated on the fabricator's details.

505.02.03 SPECIFICATIONS FOR COATING REINFORCING STEEL

- A. Coating of reinforcing steel shall conform to AASHTO M284.
1. The coating fabricator for epoxy coated reinforcing steel shall be certified by the Concrete Reinforcing Steel Institute's Certification Program for Fusion Bonded Epoxy Coating Applicator Plants.

2. A copy of the Epoxy Coating Certification along with notification starting date of coating application shall be submitted.
- B. Notification shall be given of the date and location of the coating operation, in writing, at least 10 days before the planned date for beginning the coating operation.
 1. The Engineer shall be allowed free access to plant of the coating applicator for inspection.
 2. If the representative so elects, preparation, coating, and curing of the bars shall be performed in the representative's presence.
- C. Patching or repair material that is in compliance with AASHTO M284 shall be made available from the coating manufacturer.

CONSTRUCTION

505.03.01 REINFORCING STEEL LIST

- A. In accordance with ACI 315, before placing reinforcing steel, the Contractor shall submit shop drawing details and furnish 2 copies of a list of all reinforcing steel showing sizes, lengths, and numbers of pieces and bends required to the Engineer at the site for Engineer's use in administering the contract.
 1. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy.
 2. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the plans and as specified.

505.03.02 PROTECTION OF MATERIALS

- A. Reinforcing steel shall be protected at all times from damage.
- B. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance.
- C. However, when steel has on its surface loose mill scale or dust that is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

505.03.03 BENDING

- A. Bent bar reinforcement shall be cold bent to the shape shown on the plans.
- B. Unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures.

505.03.04 PLACING AND FASTENING

- A. In accordance with ACI 315, all bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete.
- B. When the spacing of bars exceeds 1 foot in either direction, all intersections shall be tied.
- C. Distances from the vertical and horizontal forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports.

1. Blocks used for holding reinforcing bars from contact with the forms or between layers of bars shall be precast mortar blocks of approved shape and dimensions and shall have a compressive strength of not less than 3,000 psi.
 2. Metal chairs that are in contact with the exterior surface of the concrete shall be fabricated of galvanized steel, or have the steel tips plastic coated to at least 3/4 inch into the concrete, or be of stainless steel conforming to the requirements of ASTM A493, Type 430.
 3. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted.
- D. Reinforcement in any member shall be placed, and then inspected and approved by the Engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.
- E. If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

505.03.05 SPLICING

- A. In accordance with ACI 315, all reinforcement bars shall be furnished in the full lengths indicated on the plans.
- B. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the Engineer.
1. Splices shall be staggered as far as possible.
 2. Unless otherwise shown on the plans, bars near the top of beams and girders having more than 12 inches of concrete under the bar shall be lapped 35 diameters and all other bars shall be lapped 20 diameters to make the splice.
 3. In lapped splices, the bars shall be placed in contact and wired together.
- C. Welding of reinforcing steel shall be done only if detailed on the plans or authorized by the Engineer in writing. Welding shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society.
- D. Lapped splices in reinforcement shall not be used for sizes larger than No. 11.
- E. Tensile reinforcement shall preferably not be spliced at points of maximum stress. The length of lap for deformed bars shall not be less than 24 and 36 bar diameters for Grade 40 and Grade 60, respectively, nor less than 12 inches.
- F. Where lapped splices are used in reinforcement in which the critical design stress is compressive and with concrete having a strength of 3,000 psi or more, the length of lap for deformed bars shall be 20 bar and 24 bar diameters for Grade 40 and Grade 60, respectively, but not less than 12 inches. When the specified concrete strengths are less than 3,000 psi, the amount of lap shall be 1/3 greater than the values given above.
- G. Splices in spiral steel shall be made by welding or a lap of 1-1/2 turns.
- H. Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than 1 mesh in width.

505.03.06 SUBSTITUTIONS

- A. Substitution of different size bars will be permitted only with specific authorization by the Engineer.
- B. The bars substituted shall have an area equivalent to the design area or larger.

METHOD OF MEASUREMENT**505.04.01 MEASUREMENT**

- A. The calculated quantity of reinforcing steel shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment.
 - 1. The Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans.
 - 2. The Contractor's request for final measurement shall be in writing.
 - 3. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment.
 - 4. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the agency's expenses incurred by such final measurements and calculations.
- B. The calculated weights of the plain and deformed bars shall be based on the following table:

Size Number	Nominal Diameter	Weight Per Foot
	Inches	Pounds
2	0.250	0.167
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.692	7.650
18	2.256	13.600

- C. The quantity of mesh reinforcement to be measured for payment will be the number of square yards complete and in place measured along the plane of placement. No allowance will be made for laps.
- D. All measurements will be made in accordance with Subsection [109.01](#), "Measurement of Quantities."

BASIS OF PAYMENT

505.05.01 PAYMENT

- A. The accepted quantity of reinforcing steel measured as provided in Subsection [505.04.01](#), "Measurement," will be paid for at the contract unit price bid per pound.
- B. The accepted quantity of mesh reinforcement measured as provided in Subsection [505.04.01](#), "Measurement," will be paid for at the contract unit price bid per square yard.
- C. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."
- D. Payment will be made under:

PAY ITEM

PAY UNIT

Reinforcing Steel	Pound
Mesh Reinforcing	Square Yard

SECTION 601**PIPE CULVERTS – GENERAL****DESCRIPTION****601.01.01 GENERAL**

- A. This section includes general requirements that are applicable to all types of culvert pipes regardless of the material or culvert use with the following exceptions:
1. Structural plate pipe,
 2. Water distribution systems and sanitary sewer system specifications will specify the pipe to be used in their respective installations.
- B. This work shall consist of furnishing and installing pipe culverts, siphons, end sections, end walls, and so forth, as may be required to complete the work shown on the plans or established by the Engineer.
- C. The pipe shall comply with AASHTO Design and Construction LRFD Specifications most current edition and these specifications. The more stringent requirements shall apply.

MATERIALS**601.02.01 GENERAL**

- A. The materials used shall conform to the requirements in the following subsections:

Materials	Section/Subsection
Bituminous Coated Corrugated Metal Pipe and Pipe Arches	709.03.02
Clay Pipe	708.03.04
Corrugated Aluminum Pipe	709.03.04
Corrugated Metal Pipe and Pipe Arches	709.03.01
Grout and Mortar Sand	706.03.04
Nonreinforced Concrete Pipe	708.03.02
Portland Cement	701
Reinforced Concrete Pipe	708.03.01
Rubber Gaskets	707.03.06
Thermoplastic Pipe	709.03.10

- B. When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods.
1. Material samples will be obtained for laboratory testing for compliance with materials quality requirements as specified in the referenced specifications.
 2. This can be the basis for acceptance of manufacturing lots.
- C. All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.
- D. The lengths shown on the plans are approximate.

- E. For structural plate pipe and arches, comply with Section [606](#), "Structural Plate Pipe and Pipe Arch Culverts."

CONSTRUCTION

601.03.01 EARTHWORK

- A. Excavation and backfill shall conform to the requirements of Section [206](#), "Structure Excavation," and Section [207](#), "Structure Backfill," or Section [208](#), "Trench Excavation and Backfill," when the culvert is placed in a trench.
1. The pipe shall be bedded as shown in the plans and/or drawings appended to the plans or as specified in the Special Provisions.
 2. When no bedding class is specified, the requirements for normal bedding as shown in the Uniform Standard Drawings shall apply.
 3. The lines and grades will be established by the Engineer or as designated in the contract documents.
- B. Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied as directed by the Engineer before installing pipes.
- C. When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure using Class II CLSM or concrete.

601.03.02 HEADWALLS

- A. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes.
- B. Where headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer.
- C. Headwalls shall be constructed to conform to Section [501](#), "Portland Cement Concrete" and Section [502](#), "Concrete Structures."

601.03.03 END SECTIONS

- A. The bed for the end section shall be excavated to the required width and grade.
- B. For metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate from being against the inner face of the trench when the end section is in its final position. After end sections have been properly secured to the pipe, this trench shall be backfilled and firmly compacted.
- C. Precast concrete end section shall be placed with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.
- D. Thermoplastic pipe greater than 30 inches shall not be used at the open-end sections.

601.03.04 JACKED PIPES

- A. Culvert pipe to be jacked in place between the limits shown on the plans shall conform to the requirements of the respective section of pipe culverts.

- B. The strength of pipe or gauge of pipe will be determined for vertical load only in embankment conditions. Any additional reinforcement or strength required to withstand jacking pressure shall be determined and furnished by the Contractor at no additional cost to the Contracting Agency.
- C. Variation from theoretical alignment and grade at the time of completion of placing shall not exceed 0.2 foot for each 20 feet of pipe placed.
- D. The diameter of the excavated hole shall not be more than 0.1 foot greater than the outside diameter of the pipe.
 - 1. Sluicing and jetting with water will not be permitted.
 - 2. When the material tends to cave in from outside these limits, a shield shall be used ahead of the first section of pipe or the face of excavation shall not extend beyond the end of the pipe greater than 1-1/2 feet unless permitted by the Engineer.
- E. Areas resulting from caving or excavating outside the above limits shall be backfilled with sand or grout by a method that will fill the voids.

601.03.05 LAYING CULVERT PIPE

- A. Laying of culvert pipe shall conform to the requirements of the respective sections of culvert pipe.

601.03.06 EXTENDING EXISTING CULVERTS

- A. Where shown on the plans or directed by the Engineer, existing culverts shall be extended in accordance with the provisions for installing new culverts and the following additional provisions.
- B. Existing headwalls shall be demolished and removed and disposed of or moved to the extended location as indicated on the plans or ordered by the Engineer. Comply with Section [202](#), "Removal of Structures and Obstructions."
- C. A headwall that is not to be reset shall be demolished without injury to the existing culvert and removed and disposed of in accordance with the provisions of Section [202](#), "Removal of Structures and Obstructions." If shown on the plans or ordered by the Engineer, a new concrete headwall shall be constructed in accordance with the provisions of Section [501](#), "Portland Cement Concrete," of these specifications or a flared end section shall be attached thereto.

601.03.07 VIDEO INSPECTION

- A. Unless otherwise approved by the Contracting Agency, all video inspection shall be completed by a National Association of Sewer Service Companies (NASSCO) certified operator, certified at the user level minimum.
 - 1. The user shall have completed the Pipeline Assessment and Certificate Program (PACP).
 - 2. Video inspection reports must follow the NASSCO format and use standard sewer defect codes.

METHOD OF MEASUREMENT

601.04.01 MEASUREMENT

- A. The materials to be paid for under these specifications will be listed in the contract items by size, class, type, gauge, or whatever information is necessary for identification.
- B. The quantity of culvert pipe to be measured for payment will be the actual number of linear feet of pipe including the stub on end sections, complete and in place. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even 2-foot increments.
- C. Culvert pipe bends, wyes, tees, and other branches will be measured and paid for by the linear foot for the sizes of pipes involved. Wyes, tees, eccentric reducers, and other branches will be measured along centerlines to the point of intersection.
- D. Structure excavation and structure backfill, Portland cement concrete, and reinforcement required for headwalls, end walls, structures, and other items of work required by the plans and Special Provisions to complete the work, will be measured and paid for as separate items as provided for under their respective sections of these specifications, or the contract documents. Structure excavation and backfill will not be measured for payment on preformed end sections.
- E. No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, or for excavation and backfill between the limits shown on the plans for jacking the pipe. Full compensation therefor will be considered as included in the price paid for jacked pipe.
- F. Culvert pipe to be placed outside the limits for jacked pipe shall conform to the requirements of the respective section of pipe culverts. The limits for payment of structure excavation and backfill will be the original ground line before jacking pits are excavated.
- G. All measurements will be made in accordance with Subsection [109.01](#), "Measurement of Quantities."

BASIS OF PAYMENT

601.05.01 PAYMENT

- A. The accepted quantities of culvert pipe measured as specified in Subsection [601.04.01](#), "Measurement," will be listed under the respective sections of pipe culverts.
- B. When any of the various sizes, types, and gauges of pipe is installed by the jacking method, the contract price paid per linear foot for jacked pipe shall include full compensation for furnishing the pipe, excavating, jacking, furnishing and placing backfill material, and all incidentals and for doing all the work involved in jacking the pipe as specified.
- C. Full compensation for furnishing pipe with end finish, including distortion if required, will be considered as included in the price paid per linear foot for the pipe involved and no additional compensation will be allowed therefor. Full compensation for bedding will be considered included in the price paid per cubic yard for backfill or granular backfill as the case may be and such payment shall include compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

- D. Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor, and payment therefor shall be considered as subsidiary to the items involved, and no further compensation will be allowed therefor.
- E. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."

SECTION 613**CONCRETE CURB, WALK, GUTTERS, DRIVEWAYS AND ALLEY INTERSECTIONS****DESCRIPTION****613.01.01 GENERAL**

- A. Concrete curb, walk, gutters, cross gutters, driveways, and alley intersections shall be constructed of Portland cement concrete prepared as prescribed in Section [501](#), "Portland Cement Concrete."

MATERIALS**613.02.01 GENERAL**

- A. Materials shall conform to the applicable requirements of Section [501](#), "Portland Cement Concrete," Section [502](#), "Concrete Structures," and Section [505](#), "Reinforcing Steel."

CONSTRUCTION**613.03.01 GENERAL**

- A. The thickness of Type I or II aggregate base under concrete curbs, gutters, walks, driveways, and alley intersections shall be as shown on the plans or Standard Drawings or as specified in the Special Provisions.
- B. The subgrade shall be constructed true to grade and cross sections as shown on the Plans or as established by the Engineer.
- C. The subgrade shall be watered and compacted until the subgrade reaches the compaction required for the adjacent roadway or base course.

613.03.02 DIMENSIONS

- A. The dimensions of the concrete curbs, gutters, walks, driveways, and alley intersections shall be as shown on the Plans or Standards Drawings or as specified in the Special Provisions.

613.03.03 DRAINAGE OUTLETS THROUGH CURB

- A. The Contractor shall provide suitable outlets through new curb for all existing building drains along the line of the work. The Contractor shall place outlets opposite any low area on adjacent property, the drainage of which will be affected by the new work.
- B. Where sidewalk or curb will be higher than adjacent property, the Contractor shall provide at least one 4-inch diameter opening through the curb for each parcel when directed by the Engineer.

613.03.04 DRIVEWAY ENTRANCES AND ALLEY INTERSECTIONS

- A. Driveway entrances and alley intersections shall be provided in new curb at all existing driveways and alley intersections along the line of the work at locations shown on the plans or Standard Drawings, or as specified in the Special Provisions.

613.03.05 STANDARD FORMS

- A. Form material shall be free from warp, with smooth and straight upper edges and, if used for the face of curb, shall be surfaced on the side against which the concrete is to be placed.
- B. Wooden forms for straight work shall have a net thickness of at least 1-1/2 inches; metal forms for such work shall be of a gauge that will provide equivalent rigidity and strength.
- C. Curb face forms used on monolithic curb and gutter construction shall be of a single plank width when the curb face is 10 inches or less, except for those used on curb returns.
 - 1. Wooden forms used on curb returns shall be not less than 3/4 inch in thickness, cut in the length and radius as shown on the plans, and held rigidly in place by the use of metal stakes and clamps.
 - 2. The curb face shall be cut to conform exactly with the curb face batter as well as being cut in the required length and radius.
 - 3. Forms shall be of sufficient rigidity and strength, and shall be supported to adequately resist springing or deflection from placing and tamping the concrete.
 - 4. Metal forms shall not be used for curb returns or on curves of less than 250-foot radius.
- D. Form material shall be clean at the time it is used, and shall be given a coating of light oil or other equally suitable material, immediately prior to the placing of the concrete.
- E. All forms, except back planks of curb, shall be set with the upper edges flush with the specified grade of the finished surface of the improvement to be constructed, and all forms shall be not less than a depth equivalent to the full specified thickness of the concrete to be placed.
- F. Back forms shall be held securely in place by stakes driven in pairs at an interval not to exceed 4 feet, 1 at the front form and 1 at the back.
 - 1. Clamps, spreaders, and braces shall be used as necessary to ensure proper form rigidity.
 - 2. Forms for walk, gutter, and similar work shall be firmly secured by stakes driven flush with the upper edge of the form at intervals not to exceed 5 feet.
 - 3. Form stakes shall be of sufficient size and be driven to adequately resist lateral displacement.
- G. Commercial form clamps for the curb and gutter may be used, provided the clamps fulfill the requirements specified herein.

613.03.06 SLIP FORMS

- A. At the option of the Contractor and with the approval of the Engineer, slip form equipment may be used for the construction of concrete curb and gutter and concrete curb, gutter, and sidewalk except for commercial driveways and curb returns with cross gutters.
- B. If machines designed specifically for such work and approved by the Engineer are used, the results shall be equal to or better than that produced by the use of forms.
 - 1. If the results are not satisfactory to the Engineer, the use of the machines will be discontinued.

2. All applicable requirements of construction by use of forms shall apply to the use of machines.
- C. Slip form equipment shall be provided with traveling side and top forms of suitable dimensions, shapes, and strength to support the concrete for a sufficient length of time during placement to produce curb and gutter of the required cross section. The equipment shall spread, consolidate, and screed the freshly placed concrete in such a manner as to provide a dense and homogeneous product.
- D. Any curb, except on structures, may be placed by using an extrusion machine provided the finished curb is true to line and grade and the concrete is dense and of the required surface texture and strength. The combined aggregate for the concrete placed by the extrusion method shall be of such size that the percentage composition by weight will conform to the grading limits of combined aggregates as specified in Subsection [706.02.01](#), "General," for the 3/4-inch maximum grading.
- E. The grading limits shall be further restricted, if necessary, to produce concrete that after extrusion has well defined web marks of water on the surface and is free from surface pits larger than 3/16 inch in diameter.
- F. The concrete shall be of such consistency that after extrusion, the concrete will maintain the shape of the curb section without support. The concrete shall contain the maximum amount of water that will permit this result.
- G. In lieu of placing dowels and bar reinforcing steel and in advance of placing curbs on existing pavement or base, the surface shall be thoroughly cleaned and the adhesive specified below shall be applied.
 1. Cleaning of the pavement or base shall be accomplished by wire brushing or by blast cleaning if the latter method is ordered by the Engineer.
 2. The cleaned surface shall be free from dust, loose material, and oil.
- H. The adhesive shall consist of 2 components which shall be mixed together at the site of the work and shall conform to Subsection [728.03.11](#), "Binder (Adhesive), Structural Epoxy."
- I. The grade for the top of the curb shall be indicated by an offset guide line set by the Contractor from survey marks established by the Engineer.
 1. The forming tube portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine to provide, when necessary, a variable height of curb conforming to the predetermined curb grade.
 2. A grade line gauge or pointer shall be attached to the machine in such manner that a continual comparison can be made between the curb being placed and established curb grade as indicated by the offset guide line.
- J. In lieu of the above method for maintaining the curb grade, the extrusion machine may be operated on rails or forms set at uniform depth below the predetermined finished top of the grade.
- K. The top and face of the finished curb shall be true and straight, and the top surface of curbs shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge 10 feet long is laid on the top or face of the curb or on the surface of gutters, the surface shall not vary more than 0.01 foot from the edge of the straightedge, except at grade changes or curves.

613 CONCRETE CURB, WALK, GUTTERS, DRIVEWAYS AND ALLEY INTERSECTIONS

L. Extrusion Machines:

1. Crawler track driven extrusion machines shall not be used on finished course plantmix surface.
2. Concrete shall be fed to the machine at a uniform rate.
3. The machine shall be operated under sufficient uniform restraint to forward motion to produce a well compacted mass of concrete free from surface pits larger than 3/16 inch in diameter and requiring no further finishing, other than light brushing with a brush filled with water only.
4. Finishing with a brush application of grout will not be permitted.

M. Expansion joints shall be required at EC and BC of curb returns, and also along the line of work at regular intervals not to exceed 300 feet.

N. Unless otherwise specified, transverse weakened plane joints on curb and gutter produced by an extrusion machine shall be constructed at 10-foot intervals along the line of the work.

O. Weakened plane joints shall be constructed as specified in Subsection [613.03.10](#), "Weakened Plane Joints."

P. Expansion joints shall be constructed as specified in Subsection [613.03.09](#), "Expansion Joints."

Q. Curing of slip form curb, gutter, and sidewalk shall be done as specified in Subsection [613.03.15](#), "Curing."

613.03.07 PLACING CONCRETE

- A. Concrete shall be placed on a subgrade sufficiently dampened to ensure that no moisture will be absorbed from the fresh concrete.
- B. Concrete shall be placed in curb, gutter, and curb and gutter forms in horizontal layers not exceeding 6 inches in thickness, each layer being spaded along the forms and thoroughly tamped. Concrete may be placed in layers of more than 6 inches in thickness only when authorized by the Engineer and when the spading and tamping is sufficient to consolidate the concrete for its entire length.
- C. After the concrete for walk has been placed, a strike-off shall be used to bring the surface to the proper elevation when compacted. The concrete shall be spaded along the form faces and tamped to ensure a dense and compact mass, and to force the larger aggregate down while bringing to the surface not less than 3/8 inch of free mortar for finishing purposes.
- D. Concrete shall be placed in cross gutters in horizontal layers of not more than 4 inches in thickness, each layer being spaded along the form faces and thoroughly tamped into a dense and compact mass. If internal vibrators are used, the full specified thickness may be placed in 1 operation.
- E. After the concrete has been placed and tamped, the upper surface shall be struck off to the specified grade.

613.03.08 JOINTS

- A. Joints in concrete curb, gutter, and walk shall be designated as expansion joints and weakened plane joints.

613.03.09 EXPANSION JOINTS

- A. Expansion joints shall be constructed in curbs, walk, and gutter as shown on the plans, Standard Drawings, or as specified herein.
 - 1. The joints shall be filled with pre-molded joint filler conforming to Section [707](#), "Joint Material."
 - 2. No expansion joints shall be constructed in cross gutters, alley intersections, or driveways except as approved by the Engineer.
- B. One-half-inch joints shall be constructed in curb and gutter at the end of all returns except where cross gutter transitions extend beyond the curb return, in which case the joints shall be placed at the ends of the cross gutter transition.
 - 1. No joints shall be constructed in returns.
 - 2. Where monolithic curb and gutter is constructed adjacent to concrete pavement, no expansion joints will be required except at EC and BC of curb returns.
- C. Expansion joint filler 1/2-inch thick shall be placed in walk at the EC and BC of all walk returns, around all utility poles that project into the concrete along the line of the work, and in walk returns between the walk and the back of curb returns when required by the Engineer.
 - 1. At the EC and BC and around utility poles, the joint filler strips shall extend the full depth of the concrete placed.
 - 2. Joint filler strips between walk and curb shall be the depth of the walk plus 1 inch with the top set flush with the specified grade at the top of curb.
- D. All expansion joint filler strips shall be installed vertically, shall extend to the full depth and width of the work in which they are installed, and shall be constructed perpendicular to straight curb or radially to the line of the curb constructed on a curve.
 - 1. Expansion joint filler materials shall completely fill these joints to within 1/4 inch of any surface of the concrete.
 - 2. Excess filler material shall be trimmed off to the specified dimension in a neat and workmanlike manner.
 - 3. During the placing and tamping of the concrete, the filler strip shall be held rigidly and securely in proper position.

613.03.10 WEAKENED PLANE JOINTS

- A. Weakened plane joints shall be straight and constructed in accordance with paragraphs D or E below, unless otherwise shown on the plans.
- B. In walks, joints shall be transverse to the line of work and at regular intervals not exceeding 10 feet. At curves and walk returns, the joints shall be radial.
- C. In gutters, including gutters integral with curb, joints shall be at regular intervals not exceeding 10 feet. Where integral curb and gutter is adjacent to concrete pavement, the joints shall be aligned with the pavement joints where practical.
- D. **Control Joint.**
 - 1. After preliminary trowelling, the concrete shall be parted to a depth of 2 inches with a straightedge to create a division in the coarse aggregate.

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2. The concrete shall be refloated to fill the parted joint with mortar.
3. Headers shall be marked to locate the weakened plane for final joint finishing, which shall be accomplished with a jointer tool having a depth of 1/2 inch and a radius of 1/8 inch.
4. The finished joint opening shall not be wider than 1/8 inch.

E. Plastic Control Joint.

1. The joint material shall be a T-shaped plastic strip at least 1 inch deep, having suitable anchorage to prevent vertical movement, and having a removable stiffener with a width of at least 3/4 inch.
2. After preliminary trowelling, the concrete shall be parted to a depth of 2 inches with a straightedge.
3. The plastic strip shall be inserted in the impression so that the upper surface of the removable stiffener is flush with the concrete.
4. After floating the concrete to fill all adjacent voids, the removable stiffener shall be stripped.
5. During final trowelling, the edges shall be finished to a radius of 1/8 inch using a slit jointer tool.

613.03.11 FINISHING

- A. Finishing shall be completed as specified herein for the type of work being performed.

613.03.12 CURB

- A. The front forms may be stripped as soon as the concrete has set sufficiently.
- B. The face and top of the curb shall be carefully trowelled to a smooth and even finish; the top shall be finished to a transverse slope of 1/4 inch toward the gutter, with both edges rounded to a radius of 3/4 inch.
- C. The trowelled surface shall be finished with a fine hair broom applied parallel with the line of the work.
- D. The edge of the concrete at all expansion joints shall be rounded to a 1/4-inch radius.
- E. The surface of the work shall be finished as prescribed, after which the name of the Contractor, together with the year in which the improvement is constructed, shall be stamped therein to a depth of 1/4 inch in letters not less than 3/4 inch high, at BC and EC curb returns.

613.03.13 WALK

- A. The forms shall be set to place the finished surface in a plane sloping up from the top of curb at a rate of 1/4 inch to 1 foot when measured at right angles to the curb.
- B. Following placing, the concrete shall be screeded to the required grade, tamped to consolidate the concrete and to bring a thin layer of mortar to the surface, and floated to a smooth, flat, uniform surface. The concrete shall then be edged at all headers, given a preliminary trowelling, and provided with weakened plane joints.
- C. Walks shall be steel trowelled to a smooth and even finish.
1. All formed edges shall be rounded to a radius of 1/2 inch.

2. Edges at expansion joints shall be rounded to a radius of 1/8 inch.
 3. Preliminary trowelling may be done with a long-handled trowel or "Fresno," but the finish trowelling shall be done with a hand trowel.
 4. After final trowelling, walks on grades of less than 6 percent shall be given a fine hair broom finish applied transverse to the centerline.
 5. On grades exceeding 6 percent, walks shall be finished by hand with a wood float.
 6. Walks shall be remarked as necessary after final finish, to ensure neat uniform edges, joints, and weakened plane lines.
- D. Weakened plane lines, where required, shall have a minimum depth of 1-1/2 inch and a radius of 1/8 inch.
1. When longitudinal weakened plane lines are required, the lines shall be parallel to, or concentric with, the lines of the work.
 2. Walks 20 feet or more in width shall have a longitudinal center weakened plane line.
 3. In walk returns, 1 weakened plane line shall be made radially midway between the BCR and ECR.
 4. When directed by the Engineer, longitudinal and transverse weakened plane lines shall match the adjacent walk.
 5. The Contractor shall have sufficient metal bars, straightedges, and joint tools on the project.
- E. Headers shall remain in place for at least 16 hours after completion of the walk but shall be removed before the work is accepted.
- F. The name of the Contractor, together with the year in which the improvement is constructed, shall be stamped therein to a depth of 1/4 inch in letters not less than 3/4 inch, at intervals of not less than 200 feet.
1. A metal identification plate with the exposed face set flush with the finished surface of the concrete, anchored to a depth of not less than 1-1/2 inches, may be substituted for the stamping in the concrete.
 2. At least 1 such stamping or identification plate shall be made on each cement concrete job at the project.

613.03.14 GUTTER

- A. After the concrete has been thoroughly tamped in such manner as to force the larger aggregate into the concrete and bring to the top sufficient free mortar for finishing, the surface shall be worked to a true and even grade by means of a float, trowelled with a long-handled trowel (or "Fresno") and wood float finished.
1. The flow line of the gutter shall be trowelled smooth for a width of approximately 4 inches for integral curb and gutter and 4 inches on either side of the flow line on cross and longitudinal gutters.
 2. The outer edges of the gutter shall be rounded to a radius of 1/2 inch.
- B. Side forms shall remain in place for at least 24 hours after completion of the gutter, but shall be removed before the work will be accepted.
- C. Median island paving shall be as shown on the Standard Drawings.

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613.03.15 CURING

- A. Immediately after finishing operations are completed, the exposed surfaces shall be cured in accordance with Section [502](#), "Concrete Structures."

613.03.16 REPAIRS AND REPLACEMENTS

- A. Any new work found to be defective or damaged prior to its acceptance shall be repaired or replaced by the Contractor at no additional cost to the Contracting Agency and in accordance with Subsection [105.12](#), "Removal of Unacceptable and Unauthorized Work."

613.03.17 BACKFILLING AND CLEANUP

- A. Backfilling to the finished surface of the newly constructed improvement shall be complete before acceptance of the work.
- B. Upon completion of the work, the surface of the concrete shall be thoroughly cleaned and the site left in a neat and orderly condition.

613.03.18 DETECTABLE WARNINGS

- A. In accordance with the Americans with Disabilities Act (ADA), detectable warnings shall be constructed on all sidewalk ramps.
- B. Detectable warnings shall provide a tactile surface which visually contrasts with ramp and street surfaces to assist visually impaired persons in the identification of street and driveway crossings.
- C. Detectable warnings shall be constructed at the bottom of sidewalk ramps to a minimum depth of 24 inches and extending the full width of the ramp in accordance with the Standard Drawings.
- D. The materials and method of constructing the warning strips shall be as directed by the Engineer of the entity having jurisdiction over the ramp.
- E. Additional information on detectable warning materials and applications is available from the U.S. Access Board.

METHOD OF MEASUREMENT

613.04.01 MEASUREMENT

- A. The quantity of curb, gutter, and combination curb and gutter measured for payment will be the number of linear feet along the base of the curb face or along the flow line of the gutter.
- B. The quantity of sidewalk, driveway, and alley intersections shall be measured for payment by area in square feet.
- C. In the case of integral curb and walk, the width of the walk shall extend to the back face of the curb.
- D. All quantities measured for payment herein will be complete and in place.
- E. All measurements will be made in accordance with Subsection [109.01](#), "Measurement of Quantities."

BASIS OF PAYMENT

613.05.01 PAYMENT

- A. The accepted quantities of concrete measured as provided in Subsection [613.04.01](#), "Measurement," will be paid for at the contract unit price bid per linear feet for curb, gutter, curb and gutter and per square foot for sidewalks, driveways, cross gutters, and alley intersections.
- B. All excavation and base course work required for and performed during construction of the items of this section will be paid for as provided in the respective sections of the specifications; however, when the contract does not provide bid items for excavation or base course, such work required and performed will be considered subsidiary to the pay item contained herein and no further payment will be made therefor.
- C. Any excavation or backfill required other than roadway quantities will be considered subsidiary to the major items of work and no further payment will be made therefor.
- D. Reinforcing steel placed in curbs and gutters as shown on the plans or ordered by the Engineer will not be paid for directly but the cost thereof shall be considered as included in the contract bid prices for other items of work.
- E. All payments shall be made in accordance with Subsection [109.02](#), "Scope of Payment."
- F. Payment will be made under:

PAY ITEM	PAY UNIT
Type A Curb.....	Linear Foot
Type L Island Curb and Gutter	Linear Foot
Type L Curb and Gutter	Linear Foot
Concrete Sidewalk.....	Square Foot
Concrete Driveway	Square Foot
Concrete Sidewalk and Driveway	Square Foot
Concrete Alley Intersection.....	Square Foot
Concrete Cross Gutter.....	Square Foot
Concrete Commercial Driveway	Square Foot

SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 GENERAL

- A. This work shall consist of providing for traffic by constructing, maintaining, and removing detours or special detours, permitting traffic to pass through construction, and using flaggers or pilot cars and maintaining the base, or a combination of these methods as indicated in the contract documents or as directed in writing by the Engineer.

MATERIALS

624.02.01 GENERAL

- A. The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set forth herein.

CONSTRUCTION

624.03.01 SPECIAL DETOURS

- A. Special detours shall be constructed as shown on the plans or as specified. Detour locations indicated on the plans may be approximate only; the exact location shall be as staked by the Engineer.
- B. Grading for special detours shall consist of motor grader work, supplemented where necessary by other mechanical equipment, to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic. This work shall conform to Subsection [107.21](#), "Dust Control."
- C. When grading of special detours has been completed and approved by the Engineer and, if required on the plans or in the Special Provisions, the special detours shall receive surfacing materials of the kind and type specified, and the detours shall be placed and constructed in accordance with the requirements for the particular materials used.
- D. Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.
- E. Maintenance on special detours shall consist of performing any work necessary to maintain the detour satisfactorily, as ordered by the Engineer.
- F. Eradication of special detours shall consist of blade grader and scraper work supplemented by other equipment if needed. Eradication shall be performed to the extent that the ground will be restored as nearly as feasible to the original, and material disposed of, all as directed by the Engineer.

624.03.02 FLAGGERS

- A. If, in the opinion of the Engineer, controlled traffic is necessary for protection of the work or for safety of public traffic, flaggers shall be employed by the Contractor.
- B. Flaggers shall have completed an approved instructional course in flagging procedures.

- C. A prospective flagger shall possess a valid flagger card attesting satisfactory completion of said instructional course conducted by the Nevada Department of Transportation or some other approved course given by another governmental agency.

624.03.03 PILOT CARS

- A. If, in the opinion of the Engineer, it is necessary to afford additional protection to the work, workers, or public traffic, a pilot car and driver shall be used as the Engineer directs. This provision shall be in effect even though the pilot car and driver are not indicated on the plans or provided for in these specifications.
- B. Pilot cars shall be suitable vehicles in good mechanical condition and shall carry a sign which shall comply with the design and mountings as shown on the standard drawings appended to the Special Provisions, or shown on the plans.

624.03.04 MAINTAIN BASE

- A. When the proposal contains an item of "Maintain Base," the provisions of Subsection [109.03](#), "Extra and Force Account Work," shall apply.

624.03.05 EQUIPMENT RENTAL

- A. When the proposal contains an item of equipment rental, the use of such equipment shall be as directed by the Engineer or as indicated on the plans.

METHOD OF MEASUREMENT

624.04.01 MEASUREMENT

- A. Measurement for the various items involved in accommodating traffic shall be paid for as specified below:
 - 1. When the proposal contains an item Special Detours, measurement for payment will be made in accordance with the provisions of Subsection [109.03](#), "Extra and Force Account Work."
 - 2. When the proposal contains the item Flaggers, measurement for payment shall be the number of hours flaggers are used for the protection of the work or the safety of public traffic, as directed by the Engineer. If no separate item for flaggers is contained in the proposal, the cost of required flaggers shall not be measured or paid for directly but the cost thereof shall be considered as included in the payment for other items of work.
 - 3. When the proposal contains the item of Pilot Cars, the piloting as specified in the contract documents or ordered by the Engineer, will be measured by the number of hours that the pilot car and driver are actually used to lead traffic through the controlled areas.
 - 4. When the proposal contains an item Maintain Base, measurement for payment will be made in accordance with the provisions of Subsection [109.03](#), "Extra and Force Account Work."
 - 5. When equipment is used for constructing special detours or maintaining the base and such equipment is rented as indicated in the proposal, the equipment shall be measured for payment by the number of hours actually used.

BASIS OF PAYMENT

624.05.01 PAYMENT

- A. Payment for Special Detours and Maintain Base, measured as specified in Subsection [624.04.01](#), "Measurement," will be paid for by "Force Account."
- B. Eradication of special detours shall be paid for as "Force Account" and shall be included in the bid item for Special Detours.
- C. The accepted quantities of Pilot Car, measured as specified in Subsection [624.04.01](#), "Measurement," will be paid for at the contract bid price per hour for pilot car, which shall be full compensation for the vehicle, an experienced driver, all operating costs, and depreciation.
- D. When the item pilot car does not appear in the proposal, and it is necessary to protect the traveling public, in the Engineer's opinion, pilot cars shall be furnished by the Contractor and payment for pilot cars will be made in accordance with Subsection [104.03](#), "Extra Work," except, however, when the Contractor constructs and maintains a detour at Contractor's expense as provided in Subsection [104.04](#), "Maintenance of Traffic," subparagraph E.3.
- E. The accepted quantities of flaggers, when contained as a separate item in the proposal and measured as specified in Subsection [624.04.01](#), "Measurement," will be paid for at the contract bid price per hour per flagger, which shall be full compensation for the flaggers, flagging, signs, and equipment.
- F. The accepted quantities of equipment rental measured as specified in Subsection [624.04.01](#), "Measurement," will be paid for at the contract unit price bid per hour for the particular items of equipment indicated in the proposal form. The contract unit price bid per hour shall include skilled operators for each piece of equipment, fuel, lubricants, repairs, depreciation, and all expenses incidental to the operation of the equipment.
- G. All payments will be made in accordance with Subsection [109.02](#), "Scope of Payment."
- H. Payment will be made under:

PAY ITEM**PAY UNIT**

Special Detours	Force Account
Pilot Car	Hour
Flaggers	Hour
Maintain Base	Force Account
Rent Equipment (type)	Hour

SECTION 630
SANITARY SEWERS
 DESCRIPTION

630.01.01 WORK INVOLVED

- A. Unless otherwise indicated on the plans and/or specified in the Special Provisions, the construction of sanitary sewers shall include excavation and backfill, tunneling, jacking, the preparation of pipe subgrade, the construction of manholes or other structures, pipe cradle and encasement, the furnishing, placing, and testing of sewer pipe, the abandonment, removal, and/or restoration of existing improvements, the construction of appurtenances and connections, and all incidentals to sewerage construction in accordance with the plans and specifications.

630.01.02 CONFORMANCE WITH LINE AND GRADE

- A. Sanitary sewers and laterals shall be constructed to the sizes, lines, and grades as shown on the plans and/or specified in the Special Provisions.

630.01.03 EXISTING UNDERGROUND UTILITIES

- A. The sewer laterals and other underground utilities shown on the plans have been located with as much care as possible with the aid of the utility companies and office records.
- B. However, the Contracting Agency assumes no responsibility as to their exact location.

630.01.04 SEWER REPLACEMENT PROJECTS

A. Maintenance of Flow:

1. The sewer system shall be kept in continuous operation during construction.
2. Sewage flow shall be confined to closed conduits to avoid public nuisance and health hazard.

B. Bypassing Flow:

1. If the Contractor so elects, the Contractor may construct temporary pump or gravity sewer bypasses.
2. Bypasses shall be of sufficient capacity to handle peak flows without storage.
 - a. When temporary pumping is required, duplicate peak flow capacity pump units shall be provided by the Contractor to continuously handle sewage flow without interruption in the event of failure of either pump unit.
 - b. When temporary sewage suction sump or pit is constructed by the Contractor, such sump or pit shall be fully enclosed and properly vented as directed by the Engineer.

630.01.05 PROHIBITION OF DIVERSION

- A. Temporary diversion of sewage to storm drains or stream channels will not be permitted.

630.01.06 COMPENSATION FOR MAINTENANCE OF FLOW

- A. Because the method of temporary maintenance of flow during construction is at the option of the Contractor, within the limits specified above, full compensation for maintenance of flow shall be included in the prices bid in the contract proposal.

630.01.07 MECHANICAL COMPRESSION JOINT-VITRIFIED CLAY PIPE

- A. Unless otherwise indicated on the plans or in the Special Provisions, sanitary sewers constructed of vitrified clay pipe shall have mechanical compression type joints.
- B. Pipe and joint shall conform to Subsection [630.02.03](#), "Vitrified Clay Pipe Sewers and Fittings," and Subsection [630.02.04](#), "Jointing Vitrified Clay Pipe."

630.01.08 CONCRETE PIPE

- A. Unless otherwise indicated on the plans or specified in the Special Provisions, concrete pipe for sewers shall be in accordance with Subsection [630.02.06.B](#), "Quality of Pipe," paragraph B of these specifications.

630.01.09 JOINTS FOR REINFORCED CONCRETE PIPE

- A. Unless otherwise indicated on the plans or in the Special Provisions, joints for reinforced concrete pipe shall be in accordance with Subsection [630.02.06.F](#), "Joining Reinforced Concrete Pipe," paragraph F.

630.01.10 PVC SEWER PIPE

- A. Unless otherwise indicated on the plans or specified in the Special Provisions, the requirements for PVC sewer pipe shall be in accordance with Subsection [630.02.07](#), "PVC Sewer Pipe."

MATERIALS**630.02.01 GENERAL**

- A. The following specifications set forth the requirements for materials used in the installation of sanitary sewer systems.

630.02.02 MANHOLES

- A. Unless otherwise shown on the drawings or specified in the Special Provisions, materials to be used for concrete manholes shall be in compliance with ASTM C478.
- B. Manholes shall be constructed of precast reinforced concrete risers and tops complying with ASTM C478 and in accordance with the design and construction details shown on the drawings.
- C. The manhole rings and covers shall be in accordance with the Standard Drawings.
- D. All manhole bases shall be Type V concrete and placed in accordance with the Standard Drawings.

630.02.03 VITRIFIED CLAY PIPE SEWERS AND FITTINGS

- A. **General:**
 - 1. The Contractor shall furnish and install extra strength vitrified clay pipe, fittings, and appurtenances of the dimensions and to the lines and grades as shown on the plans and herein specified.
 - 2. The pipe to be installed at the various locations is identified by nominal diameter of pipe in inches followed by the acronym: VCP.

B. Quality of Pipe:

1. All vitrified clay pipe and fittings shall be of 1 class designated extra strength, of the best quality, vitrified, homogeneous in structure, thoroughly burned throughout the entire thickness, sound, impervious to moisture, and free from cracks, checks, blisters, broken extremities, or other imperfections.
2. Pipe shall give a metallic ring when struck with a hammer.
3. Pipe shall be bell and spigot pipe unless otherwise specified.
4. Pipe ends shall be square with the longitudinal axis.
5. Sockets shall be true, circular, and concentric with the barrel of the pipe.
6. The thickness of the shell, the depth of the socket, and the dimensions of the annular space shall be within the limits of permissible variation to dimension standards of the applicable provisions of ASTM C700 for the size of pipe indicated on the plans.

- C. Certification:** A certificate from the manufacturer shall be furnished with each shipment of pipe attesting that the pipe meets the requirements of these specifications, including test reports for the hydrostatic pressure test and the loading test hereinafter specified.

D. Physical Tests for Pipe and Fittings:

1. Under the supervision of and when directed by the Contracting Agency, the physical tests specified below shall be performed.
2. The cost of such supervision will be borne by the Contracting Agency and all other costs shall be borne by the Contractor.

E. Acceptance or Rejection on Results of Test:

1. If all the specimens tested meet the requirements of the test, all the pipe in the lot, shipment, or delivery corresponding to the sizes so tested shall be considered as complying with the test.
2. If, however, 10 percent or more of the specimens tested fail to meet the requirements of the test, or if more than 1 specimen fails to meet the requirements of the test when the number to be tested is less than 10, then a second selection of specimens may be made for that test.
3. The number of pipes to be tested in the second selection of pipe shall be 5 for each specimen of the first selection that failed to meet the standards.
4. If 90 percent or more of the pipe tested, including those first tested, meet the requirements of the test, the pipe in the lot, shipment, or delivery corresponding to the sizes so tested shall be considered as complying with that test; otherwise, all pipe of these sizes shall be rejected.

- F. Identification Marks:** All pipe and fittings shall be clearly marked with the name of the manufacturer or with a trademark of a size and type approved by and filed with the Engineer.

G. Tests:

1. The testing laboratory shall select at random for testing as herein specified up to 2 percent of the number of pipe in each size of pipe furnished, except that in no case shall less than 5 specimens be tested.

2. The specimens selected for testing purposes shall be sound pipe having dimensions consistent with these specifications. The lot or lots from which the test samples are taken shall be sufficient to fill the entire order for that size of pipe used in the work under the contract and, if they pass the tests, shall be so designated and marked.
 3. All pipe shall be subject to inspection at the factory, trench, or other point of delivery by the Engineer. The purpose of the inspection shall be to cull and reject any pipe that, independent of the physical tests herein specified, fails to conform to these specifications, or that may have been damaged during transportation or in subsequent handling.
- H. **Hydrostatic Tests:** In lieu of the standard ASTM absorption test, the following hydrostatic pressure test shall be substituted.
1. The hydrostatic pressure test shall precede the loading test by not less than 1 hour nor more than 3 hours and shall be applied to all the specimens received for testing in each size of pipe.
 2. When subjected to an internal hydrostatic pressure of 10 pounds per square inch for the time specified below, the accumulated moisture on the exterior surface of the pipe shall not run down the sides in such quantity that it will exceed 10 milliliters per linear foot.

Thickness of Barrel	Testing Time
Up to and including 1 inch	7 minutes
Over 1 inch and including 1-1/2 inches	9 minutes
Over 1-1/2 inches and including 2 inches	12 minutes
Over 2 inches and including 2-1/2 inches	15 minutes
Over 2-1/2 inches and including 3 inches	18 minutes
Over 3 inches	21 minutes

I. **Loading Tests:**

1. The loading test shall be the 3-edge bearing, shall conform to the applicable provisions of ASTM C301, and shall be applied to all specimens selected for testing, except that loading to test ultimate strength will not be required.
2. Pipe shall withstand the following loads:

Nominal Pipe Size In Inches	Minimum Test Loads Pounds Per Linear Foot
4 and 6	2,000
8	2,200
10	2,400
12	2,600
15	2,900
18	3,300
21	3,850
24	4,400
27	4,700
30	5,000
33	5,500
36	6,000

Nominal Pipe Size In Inches	Minimum Test Loads Pounds Per Linear Foot
39	6,600
42	7,000

3. The net inside length of the pipe from the bottom of the socket to the spigot end of the pipe shall be used as the divisor to calculate the load per linear foot.
- J. **Inspection Independent of Tests:** The following imperfections in a pipe or special fitting will be considered injurious and cause for rejection without consideration of the test results hereinabove specified:
1. There shall be no fractures or cracks passing through the barrel or socket, except that a single crack at the spigot end of the pipe not exceeding 75 percent of the depth of the socket, or a single fracture in the socket not exceeding 3 inches around the circumference nor 2 inches lengthwise may be permitted.
 2. Lumps, blisters, pits or flakes on the interior surface of a pipe or fitting.
 3. When the bore or socket of the pipe varies from a true circle more than 3 percent of its nominal diameter.
 4. When a pipe or fitting, designated to be straight, deviates from a straight line more than 1/16 inch per linear foot. The deviation shall be measured from a straight edge at a point midway between the ends of the pipe.
 5. A piece broken from either the socket or spigot end.
 6. Tramp clays, gorge, or other foreign matter fused permanently to the exterior or interior surface of the pipe or fitting.
 7. Pipes that, when placed in a vertical position, do not give a metallic ring when struck with a hammer.

630.02.04 JOINTING VITRIFIED CLAY PIPE

- A. Vitrified clay pipe and fittings shall be furnished with mechanical compression joints or compression couplings or approved equal.
- B. Materials for compression joints and couplings shall conform to ASTM C425.
- C. An approved lubricant shall be used in the assembling of the pipe and no further sealing element will be required.

630.02.05 STOPPERS

- A. Stoppers for sewage line shall be as approved by the pipe manufacturer.

630.02.06 REINFORCED CONCRETE PIPE

- A. The Contractor shall furnish and install reinforced concrete pipe, fittings, and appurtenances of the dimensions and to the lines and grades as shown on the plans and herein specified. The pipe to be installed at the various locations is identified by nominal diameter of pipe in inches followed by the acronym: RCP.
- B. **Quality of Pipe:**
 1. All reinforced concrete pipe and fittings shall be made by the centrifugal process conforming to ASTM C76.

2. The pipe sections shall be manufactured with flared bell and spigot-type joints and incorporate O-ring rubber gaskets as their positive and flexible seal against internal or external hydrostatic pressures.
 3. Pipe walls shall be designed and reinforced for 1350 D-load (Class III) according to ASTM C76.
 4. Unless shown or specified otherwise, all RCP that is to carry sewage shall have not less than 2 inches of concrete between the inside of the pipe and the reinforcing, and not less than 1 inch clear between exterior of pipe and its reinforcing.
- C. **Identification Marks:** The following information shall be clearly marked on each pipe section:
1. Permissible D-load strength
 2. Name or trademark of manufacturer
 3. Date of manufacture
 4. Letter "T" 6 inches or more from end of pipe to indicate the top of pipe for correct installation when elliptical reinforcement is used.
 5. Markings shall be indicated on the pipe sections or painted thereon with waterproof paint.
- D. **Tests:** Concrete pipe may be tested by the Engineer by one or more of the tests specified below. The manufacturer shall furnish without charge all necessary equipment and samples for making the tests. All tests shall be made in accordance with ASTM C76.
1. **Absorption Test:** The absorption test may be made to determine the amount of moisture absorbed by the concrete.
 2. **Three-Edge Bearing Strength Test:** The 3-edge bearing test may be made to determine the strength of the pipe and the "D" load that the pipe will withstand.
 3. **Core or Cylinder Test:** Cores may be cut from the concrete of the pipe or test cylinders case of the concrete as placed for the purpose of determining the strength of the concrete in the pipe.
 4. **Visual Test and Inspections:**
 - a. Visual inspection may be made by the Engineer before and/or after the delivery of the pipe for the purpose of determining the placement of the reinforcement, size, shape, fractures, spalls, honeycomb, or other imperfections or damage.
 - b. The Contractor shall notify the Engineer not less than 24 hours in advance of beginning manufacture of the pipe.
 - c. The Engineer shall have access to all operations of the manufacture and may inspect and test any or all equipment, materials, and operations used in the manufacturing, handling, and curing of the pipe.
- E. **Cement:** Portland cement shall conform to ASTM C150, Type V (high sulfate resistant).
- F. **Joining Reinforced Concrete Pipe:** Joints shall be made watertight and root-tight in an approved manner in accordance with ASTM C443.
1. **Joint Design:**
 - a. Pipe units shall be manufactured with flared bell and spigot-type joints.

- 1) The spigot end shall be provided with a gasket groove and the joint shall be sealed by a round rubber gasket in compression between the bell and spigot surfaces.
 - 2) The length of each gasket shall be volumetrically determined so that it will substantially fill the joint recess.
 - 3) The gasket shall be the sole element depended upon to make the joint watertight.
 - b. The joints shall be self-centering and, upon proper closure of the joint, the rubber gasket shall be uniformly confined with the spigot groove and enclosed. In this condition, the gasket shall not support the weight of the pipe and shall function solely as the water seal element under all normal conditions of service, including expansion, contraction, and settlement.
 - c. The joint shall be designed to withstand, without cracking or fracturing, the forces caused by the compression of the gasket and the required hydrostatic pressure.
2. **Rubber for Gaskets:**
- a. The rubber-type compound used for manufacture of the solid continuous ring gaskets of circular cross section shall be neoprene.
 - b. The compound shall contain no factice, reclaimed rubber, or any deleterious substance. All gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free from porosity, blisters, pitting, and other imperfections.
3. The neoprene shall meet the following physical requirements when tested in accordance with the applicable sections of Federal Test Method Standard No. 601 and appropriate ASTM test methods as indicated.
- | | |
|---|------------------|
| Neoprene (by volume) min. % | 50 |
| Tensile strength, psi, min. ASTM D412 | 1800 (12.41 MPa) |
| Elongation at rupture, percentage, min. ASTM D412 | 425 |
| Shore durometer, Type A (Center of range preferred) | |
| ASTM D2240 (the test shall be performed on the flat cross section of 1/2-inch length of gasket) | 40±5 |
| Compression set, percentage of original deflection, max. Method B (1/2-inch long section of gasket, constant deflection; 22 hours at 158 degrees F) ASTM D395 | 20 |
| Accelerated aging in air (70 hours at 212 degrees F) ASTM D573 Tensile strength, percentage of original strength, min. | 85 |
| Hardness change, percentage, max. | +15 |
| Water absorption, percent vol. change, max. 70 hours at 212 degrees F | 10 |
| Ozone 6 ppm, 25 percent elongation, 2 hours at 100 degrees F max. | No Cracking |
| Specific Gravity | 1.30 to 1.45 |
4. After the joint is assembled, and if so directed by the Engineer, a thin metal feeler gauge shall be inserted by the Contractor between the bell and the spigot and the position of the rubber gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the

gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked, all at no additional cost to the Contracting Agency.

630.02.07 PVC SEWER PIPE

- A. This subsection specifies general requirements for unplasticized polyvinyl chloride (PVC) plastic gravity sewer pipe with integral wall bell and spigot joints for the conveyance of domestic sewage.
- B. **Materials:** Pipe and fittings shall meet extra strength minimum of SDR-35 of ASTM D3034.
- C. **Pipe:**
 - 1. All pipe shall be suitable for use as a gravity sewer conduit.
 - 2. Provisions shall be made for contraction and expansion at each joint with a rubber ring.
 - 3. The bell shall consist of an integral wall section with a solid cross section rubber ring, factory assembled and securely locked in place to prevent displacement.
 - 4. The rubber ring shall meet ASTM D1869.
 - 5. Sizes and dimensions shall be as shown in this specification.
 - 6. Standard lengths shall be 20 feet and 12.5 feet ± 1 inch.
 - 7. At manufacturer's option, random lengths of not more than 15 percent of total footage may be shipped in lieu of standard lengths.
- D. **Fittings:** All fittings and accessories shall be as manufactured and furnished by the pipe supplier or approved equal and have bell and/or spigot configurations identical to that of the pipe.
- E. **Physical and Chemical Requirements:** Pipe shall be designed to pass all tests at 73 degrees F (± 3 degrees F).
- F. **Pipe Stiffness:** Minimum "pipe stiffness" at 5 percent deflection shall be 46 for all sizes when tested in accordance with ASTM D2412.
- G. **Joint Tightness:**
 - 1. Assemble 2 sections of pipe in accordance with the manufacturer's recommendation.
 - 2. Subject the joint to an internal hydrostatic pressure of 25 psi for 1 hour.
 - 3. Consider any leakage a failure of the test requirements.
- H. **Flattening:** There shall be no evidence of splitting, cracking, or breaking when the pipe is tested as follows:
 - 1. Flatten 6-inch long specimen of pipe between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe.
 - 2. The rate of loading shall be uniform and such that the compression is completed within 2 to 5 minutes.
- I. **Drop Impact Test:**
 - 1. Pipe (6-inch long section) shall be subjected to impact from a free falling tup (20-pound Tup A) in accordance with ASTM D2444.

2. No shattering or splitting (denting is not a failure) shall be evident when the following impact energy is applied.

Nominal Size	4-inch	6-inch	8-inch	10-inch	12-inch
Feet-Pounds	140	210	210	220	220

- J. **Acetone Immersion Test:** After 2 hours of immersion in a sealed container of anhydrous (99.5 percent pure) acetone, a 1-inch long sample ring shall show no sign of flaking on exterior or interior surfaces when tested in accordance with ASTM D2152.
- K. Manhole couplings manufactured by the pipe manufacturer shall be used at all manholes.
- L. A gauge plug furnished by the pipe manufacturer shall be pulled through the pipe from manhole to manhole to check the pipe for overdeflection. This check will be performed after the pipe is backfilled.

SIZES, DIMENSIONS, AND TOLERANCES

Nominal Size (inch)	Outside Diameter		Minimum Wall Thickness	Weight/Pounds 20-foot Length
	Average	Tolerance		
4	4.215	±0.007	0.125	20.4
6	6.275	±0.009	0.18	43.9
8	8.4	±0.010	0.24	78.8
10	10.5	±0.013	0.3	123.4
12	12.5	±0.016	0.36	176.4

M. **Marking:**

1. Pipe in compliance with this standard shall be clearly marked as follows at intervals of 5 feet or less:
 - a. Manufacturer's name or trademark.
 - b. Nominal pipe size.
 - c. The legend "Type PSM SDR-35 PVC Sewer Pipe."
 - d. ASTM D3034.
2. Fittings in compliance with this standard shall be clearly marked as follows:
 - a. Manufacturer's name or trademark.
 - b. Nominal size.
 - c. Material designation "PVC."
 - d. PSM.
 - e. ASTM D3034.

CONSTRUCTION

630.03.01 EXCAVATION AND BACKFILL

- A. Excavation and backfill shall be in accordance with the Standard Drawings for excavation and backfill of sanitary sewers.

630.03.02 TRENCHES

- A. Trenches shall be in accordance with Section [208](#), "Trench Excavation and Backfill."

630.03.03 PIPE BEDDING AND LAYING**A. Pipe Bedding:**

1. Pipe bedding shall be in accordance with Subsection [208.03.12](#), "Pipe Bedding," and the Standard Drawings.
2. Place pipe that is to be bedded in a concrete cradle or encased in concrete in proper position on temporary supports consisting of concrete blocks or bricks. When necessary, rigidly anchor or weight the pipe to prevent flotation when the concrete is placed.
3. Place concrete for cradles, arches, and encasement uniformly on each side of the pipe and deposit at approximately its final position.
 - a. Do not move concrete more than 5 feet from its point of deposit.
 - b. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.

B. Pipe Laying:

1. Protect the pipe during handling against impact, shocks, and free fall. Do not permit hooks to come in contact with premolded joint surfaces.
2. Handle pipe with premolded joint rings or attached couplings so that no weight, including the weight of the pipe itself, will bear on or be supported by the jointing material.
3. Take care to avoid dragging the spigot ring on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.
4. After delivery alongside the trench, carefully examine each piece of pipe for soundness and specification compliance. Acceptable pipe may be marked with paint or other permanent marking material so that the marks are plainly visible after installation in the trench and before the pipe is covered.
5. Clean joint contact surfaces immediately prior to jointing.
6. Use lubricants, primers, or adhesives recommended by the pipe or joint manufacturer.
7. Unless otherwise required, lay all pipe straight between changes in alignment and at uniform grade between changes in grade.
 - a. Excavate bell holes for each pipe joint.
 - b. When jointed in the trench, the pipe shall form a true and smooth line.
8. Divert surface water from the trench area to the greatest extent practicable without causing damage to the adjacent property. There shall be no freestanding water on the base upon which the pipe is laid.
9. Unless otherwise permitted by the Engineer, start pipe laying at the lowest point and install the pipe so that the spigot ends point in the direction of flow.
10. At times when the pipe laying is not in progress, the open end of the pipe shall be closed with a tight-fitting cap or plug to prevent the entrance of foreign matter into the pipe.
 - a. These provisions shall apply during the noon hour as well as overnight.

- b. In no event shall water that has infiltrated into the trenches be allowed to enter into existing sewage flows.
- c. The pipeline under construction may be used to remove water that has infiltrated into the trenches provided it is removed before entering the existing flows.

630.03.04 DEWATERING

- A. All water shall be removed so the top of base is dry for pipe laying.
- B. In no case shall water from the dewatering process be allowed into existing sewer lines.

630.03.05 JACKING

- A. **Equipment:** The jacking equipment used for this work shall be of serviceable quality and installed and operated in accordance with standard practice for this type of work and the approval of the Engineer.
- B. **Casing:**
 - 1. The jacked casing shall be large enough and so located that the sewer main can be jacked through and adjusted true to line and grade.
 - 2. The annular space between the sewer pipe and the casing shall be sand filled, and any voids outside the casing shall be completely filled by pressure grouting.
- C. **Flotation:** Sewer pipe shall be prevented from floating.

630.03.06 TUNNELING

- A. **Size:** The tunnel shall be large enough so that the sewer main can be jacked through true to line and grade.
- B. **Grouting:**
 - 1. The annular space between the sewer main and the tunnel wall shall be completely filled by pressure grouting.
 - 2. The sewer pipe shall be prevented from floating during the grouting operation.

630.03.07 SEWER LATERALS

- A. **General:**
 - 1. The term "sewer lateral" is defined as a branch sewer laid from main sewer to a point on the property line from which private sewer service can be obtained by proper extensions.
 - 2. Sewer laterals shall be constructed of the same type of sewer pipe and the same type of joint as is used in the trunk line sewer in accordance with the plans and all applicable provisions of these specifications.
- B. **Location Mark:** Where the curb is existing or is to be constructed as a part of the same job under which sewer laterals are installed, the location of the sewer lateral shall be plainly marked by stamping or chiseling the letter "S" in the face of the curb with a letter not less than 1 inch high and 3/16 inch deep.
- C. **Wye Connection:**
 - 1. A wye shall be installed in the main for each sewer lateral and lateral connection specified to be constructed.

2. Not more than 1 lateral shall be connected in 1 length of sewer main pipe.
- D. **Lateral Connections:** Existing sewer laterals cut by construction of new sewers shall be connected to the new sewer main with pipe and fittings of the same diameter and material as that of the existing lateral.
- E. **Lateral Extension Connections:** Existing sewer laterals that must be extended to reach new sewer mains shall be disconnected at the existing sewer main, and shall be extended and connected to the new sewer main using pipe and fittings of the same diameter and material as that of the existing lateral.
- F. **Laterals Not Shown:**
 1. Laterals uncovered by the construction that are not shown on the plans shall be connected to the new sewer line.
 2. Such lateral connection work will be paid for at appropriate unit bid prices.

630.03.08 HOUSE CONNECTIONS

- A. **Definition:** House connections are those sewer laterals constructed on private property from the property line to a point of connection with the existing building (house) sewer
- B. **Plumbing Code:** All house connections shall conform to the provisions of the applicable Plumbing Code.
- C. **Conduct of Operations:**
 1. The Contractor shall conduct operations to result in a minimum of interference to the existing improvements.
 2. The Contractor shall restore the area to its original condition after constructing house connections.
 3. Landscaping shall be carefully restored either by planting new plants of the same variety and size as those removed or by stockpiling and replacing the existing plants in a strong growing condition.

630.03.09 APPURTENANCES

- A. **Stubs and Plugs:**
 1. Stubs in all sewer manholes shall consist of a short length of vitrified clay extra strength pipe with mechanical compression joints, unless otherwise specified or shown.
 2. All stubs shall be plugged.
- B. **Material:**
 1. Plugs for vitrified clay mechanical compression joint pipe, up to and including 12 inches in diameter, shall be furnished where required by the plans.
 2. Plugs shall consist of vitrified clay disks with approved plastic joint component or shall consist of a resilient material plug of controlled design and dimensions for mating with the pipe to which it is to be applied.
 3. A force-fit of joint shall be made between the plug and the pipe.

630.03.10 ABANDONMENT OF EXISTING SEWERS

- A. **Manholes to be Abandoned:** Manholes shall be abandoned as follows:
1. Concrete base shall be cracked or broken to provide drainage.
 2. The manhole shall be removed from site. The remaining hole shall be backfilled and pavement shall be replaced as specified in Subsection [630.03.01](#), "Excavation and Backfill."
 3. The manhole material shall be returned to the Contracting Agency unless otherwise specified.
- B. **Sewer Mains to be Abandoned:** Sewer mains shall be abandoned as follows:
1. Excavate and remove pipe.
 2. Excavate and crush pipe in place.
 3. Grout pipe with sand or grout and plug ends.
 4. Method as approved by Engineer.
- C. **Plugs for Sewer Mains to be Abandoned:** Plugs in sewer mains to be abandoned shall be Portland cement concrete a minimum of 12 inches thick in 15-inch mains and larger and a minimum of 6 inches thick in sewer mains smaller than 15 inches.

630.03.11 VITRIFIED CLAY PIPE FITTINGS

- A. Vitrified clay pipe fittings shall include branches of every type and stoppers. Fittings shall be furnished and installed at the locations, to the grades, and of type and size shown on the plans and in conformance with these specifications.
- B. **Branches:**
1. Branches of type shown on the plans shall be furnished with connections of the sizes specified and shall be securely and completely fastened to the barrel of the pipe in the process of manufacture.
 2. Tee branches shall have their axis perpendicular to the longitudinal axis of the pipe. Wye branches shall have their axis approximately 45 degrees (unless otherwise specified on the plans) to the longitudinal axis of the pipe, measured from the socket end. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length to permit making a proper joint when the connecting pipe is inserted in the branch socket.
 3. The quality of vitrified clay pipe fittings and the joints for fittings shall conform to the applicable provisions of these specifications.
- C. **Installation of Branches:**
1. Vitrified clay pipe wyes, tees, and other types of branches shall be furnished and installed along with vitrified clay pipe sewer.
 2. Wyes of size specified on the plans shall be installed for all sewer house connections and for future sewer house connections as shown on the plans, or specified in the detailed specifications.
 3. Tees shall be installed for chimneys shown on the plans.

4. The longitudinal barrel of branch fittings to be placed in line and grade with the vitrified clay pipe sewer mains shall be of the same diameter, quality, and type as the sewer.
5. Installation and bedding for branches shall conform to the applicable provisions set forth for vitrified clay sewer pipe.
6. Unless otherwise specified, the branch of wye fittings shall be inclined upward at an angle not greater than 45 degrees from a horizontal line.
7. If so shown on the plans, tees with standard tee foundations shall be substituted for wye branches.
8. No wye or tee for sewer house connection branch shall be placed closer than 5 feet, in the downstream side, to the centerline of any structure.

630.03.12 VITRIFIED CLAY PIPE AT MANHOLES OR STRUCTURES

- A. A 2-foot vitrified clay pipe joint of the same inside diameter as the adjoining pipe shall be placed at the inlet and outlet to each manhole or structure as shown on the drawings.
- B. The pipe may be laid through the manhole to provide a smooth invert. In this event, the pipe will be broken out and the base grouted to create a smooth shelf.

630.03.13 BLANK

630.03.14 TEST FOR LEAKAGE AND INFILTRATION

- A. **General:** It is the intent of the plans and specifications that the completed sewer pipes of all types, along with manholes and other appurtenances, shall be watertight.
 1. Each section of sewer between 2 successive manholes shall be tested for leakage. Where excessive groundwater is encountered or dewatering procedures are required, an infiltration test shall also be made as set forth herein.
 2. If either the leakage or infiltration rate as shown by the tests specified herein is greater than the amount specified, the pipe joints shall be repaired or, if necessary, the pipe shall be removed and relaid by the Contractor at no additional cost to the Contracting Agency. The sewer will not be considered acceptable until the leakage and infiltration rates, as determined by test, are less than the allowable.
- B. **Leakage Test:**
 1. **General:**
 - a. The Contractor shall water test for leakage all sections of pipe between structures.
 - b. Where groundwater is encountered, then both the infiltration test and leakage test shall be made.
 - c. Where the difference in elevation between the invert of the upper structure and the invert of the lower structure is more than 10 feet, then the air test shall be made.
 2. **Water Test:**
 - a. Each section of sanitary sewer, between 2 successive structures, shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper structure with plugs or stoppers and filling the pipe and structure

with water to a point 4 feet above the invert of the open sewer in the upper structure.

- b. The total leakage shall be the decrease in volume of water in the upper structure.
 - 1) The leakage shall not exceed 200 gallons per day per inch of nominal diameter of pipe per mile of sewer pipe being tested.
 - 2) The length of house connections shall not be used in computing the length of sewer main being tested.
- c. If leakage, as shown by the test, is greater than allowed, the pipe shall be overhauled and, if necessary, replaced and relaid until the joints and pipe hold satisfactorily under this test.
- d. All tests shall be completed before the street or trench is resurfaced unless otherwise directed by the Engineer.
- e. The Contractor shall furnish all labor and materials for making the tests required at no additional cost to the Contracting Agency.

3. **Air Test Procedure:**

- a. Each section of sewer between 2 successive manholes shall be tested by plugging all pipe outlets with suitable test plugs.
- b. Air shall be slowly added until the internal pressure is raised to 4.0 psig.
- c. The compressor used to add air to the pipe shall have a blow-off valve set at 5 psig to ensure that at no time the internal pressure in the pipe exceeds 5 psig.
- d. The internal pressure of 4 psig shall be maintained for at least 2 minutes to allow temperature to stabilize, after which the air supply shall be disconnected and the pressure allowed to decrease to 3.5 psig.
- e. The time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig shall be measured and the results compared with the values as specified in ASTM C828.
- f. For convenience, specification times required for the pressure drop from 3.5 psig. to 2.5 psig. are tabulated on the following chart:

**SPECIFICATION TIME (MIN:SEC) REQUIRED
FOR PRESSURE DROP FROM 3.5 TO 2.5 PSIG
WHEN TESTING ONE PIPE DIAMETER ONLY
(PIPE DIAMETER, INCHES)**

	4	6	8	10	12	15	18	21	24	27	30	33	36	39	42
25	0:04	0:10	0:18	0:22	0:27	0:32	0:36	0:45	0:54	1:03	1:12	1:21	1:30	1:39	1:50
50	0:09	0:21	0:36	0:45	0:54	1:03	1:12	1:30	1:48	2:06	2:24	2:42	3:00	3:18	3:39
75	0:14	0:32	0:54	1:08	1:21	1:34	1:48	2:15	2:42	3:09	3:36	4:03	4:30	4:57	5:29
100	0:18	0:42	1:12	1:30	1:48	2:06	2:24	3:00	3:36	4:12	4:48	5:24	6:00	6:36	7:18
125	0:22	0:52	1:30	1:52	2:15	2:38	3:00	3:45	4:30	5:15	6:00	6:45	7:30	8:15	9:08
150	0:27	1:03	1:48	2:15	2:42	3:09	3:36	4:30	5:24	6:18	7:12	8:06	9:00	9:54	10:57
175	0:32	1:14	2:06	2:38	3:09	3:40	4:12	5:15	6:18	7:21	8:24	9:27	10:30	11:33	12:47
200	0:36	1:24	2:24	3:00	3:36	4:12	4:48	6:00	7:12	8:24	9:36	10:48	12:00	13:12	14:36

**SPECIFICATION TIME (MIN:SEC) REQUIRED
FOR PRESSURE DROP FROM 3.5 TO 2.5 PSIG
WHEN TESTING ONE PIPE DIAMETER ONLY
(PIPE DIAMETER, INCHES)**

	4	6	8	10	12	15	18	21	24	27	30	33	36	39	42
225	0:40	1:34	2:42	3:22	4:03	4:44	5:24	6:45	8:06	9:27	10:48	12:09	13:30	14:51	16:26
250	0:45	1:45	3:00	3:45	4:30	5:15	6:00	7:30	9:00	10:30	12:00	13:30	15:00	16:30	18:16
275	0:50	1:56	3:18	4:08	4:57	5:46	6:36	8:15	9:54	11:33	13:12	14:51	16:30	18:09	20:06
300	0:54	2:06	3:36	4:30	5:24	6:18	7:12	9:00	10:38	12:36	14:24	16:12	18:00	19:48	21:54
350	1:03	2:27	4:12	5:15	6:18	7:21	8:24	10:30	12:36	14:42	16:48	18:54	21:00	23:06	25:33
400	1:12	2:48	4:48	6:00	7:12	8:24	9:36	12:00	14:24	16:38	19:12	21:36	24:00	26:24	29:12
450	1:21	3:09	5:24	6:45	8:06	9:27	10:48	13:30	16:12	18:54	21:36	24:18	27:00	29:42	32:51
500	1:30	3:30	6:00	7:30	9:00	10:30	12:00	15:00	18:00	21:00	24:00	27:00	30:00	33:00	36:30

- g. If the length to be tested is not calculated above, the following formula can be used to calculate the time required for the specified pressure drop.

TABLE 1 MINIMUM TEST TIME FOR VARIOUS PIPE SIZES

Nominal Pipe Size, in.	T(time), min/100 ft.	Nominal Pipe Size, in.	T(time), min/100 ft.
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

$$T = \frac{\text{Time in Table 1} \times L}{100}$$

WHERE

T = Time for pressure to drop from 3.5 psig to 2.5 psig in minutes

L = Length of line between manholes

- h. If the pressure drop from 3.5 psig to 2.5 psig occurs in less time than the above tabulated or calculated values, the pipe shall be overhauled and, if necessary, replaced and relaid until the joints and pipe hold satisfactorily under this test.
- i. If the section of line to be tested includes more than one pipe size, calculate the test for each size and add the test times to arrive at the total test time for the section.
- j. At the end of air testing, all manholes shall be water tested to ensure they are water tight in accordance with Subsection [630.03.14.A](#), "General."

4. Test for Infiltration:

- a. If, in the construction of a section of the sewer between structures, excessive groundwater is encountered, the test for leakage shall also be required as described in the subsection on leakage test.
- b. For infiltration tests, the end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of groundwater, and pumping of groundwater shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.
- c. The infiltration shall not exceed 0.028 gallons per minute, per inch of diameter, per 1,000 feet of mainline sewer being tested, and does not include the length of house laterals entering that section.
- d. Where any infiltration in excess of this amount is discovered before completion and acceptance of the sewer, the sewer shall be immediately uncovered at no additional cost to the Contracting Agency and the amount of infiltration reduced to a quantity within the specified amount of infiltration before the sewer is accepted.
- e. Should, however, the infiltration be less than the specified amount, the Contractor shall stop individual leaks that may be observed when ordered to do so by the Engineer.
- f. The Contractor shall furnish and install calibrated flumes, or "V" notch weirs, for measuring infiltration and making the tests required at no additional cost to the Contracting Agency.
- g. All tests shall be completed before street or trench is resurfaced, unless otherwise directed by the Engineer.

630.03.15 TESTS FOR ALIGNMENT AND GRADE, AND DAMAGED OR DEFECTIVE PIPE IN PLACE

- A. After the pipe has been installed, tested for leakage, backfilled to existing grade, and manholes raised, the sewer shall be "balled" from manhole to manhole with a sewer scrubbing ball of type and size, approved by the Engineer, with the assistance of the Contractor's forces.
- B. All "balling" and "mirroring" shall be done in the presence of the Engineer and shall constitute tests for alignment, grade, damaged or defective pipe in place, and any other type of faulty installation.
- C. Should "balling" or "mirroring" indicate any faulty installation of the pipe, repairs or replacements shall be made at no additional cost to the Contracting Agency and as directed by the Engineer.
- D. Full compensation for making these tests shall be included in the contract unit prices and no additional allowance will be made therefor.
- E. Where sewers are of sufficient size to permit hand cleaning, "balling" may be omitted.

METHOD OF MEASUREMENT**630.04.01 MEASUREMENT**

- A. The method of measurement shall be as specified by the Contracting Agency.

BASIS OF PAYMENT

630.05.01 PAYMENT

- A. Payment shall be as specified by the Contracting Agency.

SECTION 685

VIDEO ENCODER

DESCRIPTION

685.01.01 GENERAL

- A. This specification describes the functional, performance, environmental, submittal, documentation, and warranty requirements, as well as the method of measurement and basis of payment, for a rugged field deployable and user selectable Moving Picture Experts Group (MPEG)-2 and MPEG-4 video encoder.
 - 1. This video encoder will transmit data via RS-232/422 and accept standard National Television Standards Committee (NTSC) composite video signal as input, digitally compress it, and transmit it over the Freeway and Arterial System of Transportation (FAST) communication network.
 - 2. The video encoder shall comply with this specification to operate within the FAST Arterial Management System and Freeway Management System.
- B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.
 - 1. The Engineer shall be notified prior to the delivery to the TMC.
 - 2. No partial shipments will be accepted.
 - 3. All equipment supplied on this project shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.
- C. All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS

685.02.01 FUNCTIONAL REQUIREMENTS

- A. The video encoder shall comply with the following standards:
 - 1. National Electronics Manufacturers Association (NEMA) TS-1: Section 2, Traffic Control System. The following clauses apply:
 - a. 2.1.2: Voltage.
 - b. 2.1.3: Frequency Range.
 - c. 2.1.4.1: Power Interruption.
 - d. 2.1.5: Temperature and Humidity, as modified herein.
 - e. 2.1.6: Transients, Power Service.
 - f. 2.1.7: Transients, Input-Output terminals.
 - g. 2.1.8: Non-Destruct Transient Immunity.
 - h. 2.1.12: Vibration.
 - i. 2.1.13: Shock.
 - 2. International Organization for Standardization (ISO) 9001: Quality Assurance, MPEG-2, ISO/13818-2 Video Compression.

3. Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part 3, CSMA/CD Access Method and Physical Layer Specifications.
 4. Federal Communications Commission Rules and Regulations, Vol. II: Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (product electromagnetic compatibility is required).
 5. Underwriters Laboratories, Inc. (UL) 60950: Safety Requirements for IT Equipment (applicable to equipment safety).
 6. Military Handbook MIL-HDBK-217F-2: Reliability Prediction of Electronic Equipment, Notice 2.
- B. Detailed Requirements:
1. The video encoder shall support the following video features:
 - a. Signal format: 30 fps, NTSC color.
 - b. Resolution: 720 x 480 (full resolution).
 - c. Video Settings: Contrast, saturation, brightness, and hue.
 2. The video encoder shall support bi-directional serial communications over Ethernet via the following methods:
 - a. Encoder serial port to decoder serial port data stream.
 - b. Internet Protocol (IP) socket to encoder serial port.
 3. The video encoder shall support full-duplex serial interface and data rates up to 57.6 bps.
 - a. The baud rate, stop bits, data bits, and flow control shall be user configurable.
 - b. The serial interface shall be transparent to the device (i.e., no additional or special protocols shall be required to communicate between the closed circuit television (CCTV) control interface and the encoder).
 4. The video encoder shall support the following:
 - a. Encoding Formats: The unit shall be capable of being soft configured to perform MPEG-2 ISO/13818-2 video compression and MPEG-4 ISO/14496 video compression.
 - b. The encoder shall be capable of being soft configured to produce elementary, or transport stream.
 - c. Bandwidth:
 - 1) 1.5 Mbps to 10 Mbps for MPEG-2 and 64 Kbps to 5 Mbps for MPEG-4.
 - 2) The data rate shall be defined as the maximum committed bandwidth to be utilized, which includes bursting.
 - 3) The default bandwidth for the video encoder shall be set to 5 Mbps for MPEG-2 and 1 Mbps for MPEG-4.
 - d. Latency: The end-to-end latency between the video encoder and the video decoders shall be no more than 250 ms while operating at a rate of 5 Mbps.
 5. The video encoder shall support the following network features:
 - a. Ethernet Interface: 10/100 Mbps, Full-Duplex, Auto Negotiate (802.3), RJ-45.

- b. Static IP Addressing: Class A, B, and C.
 - c. SNMP (MIB2).
 - d. Unicast and Multicast (IGMP V2).
 - e. Gateway Configuration.
 - f. Adjustable Packet Payload Size.
- 6. The video encoder shall support:
 - a. Command Line Interface.
 - b. Telnet.
 - c. Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).
 - d. The video encoder shall have an integrated web interface that provides remote configuration.
 - e. Reset/Reboot and firmware upload shall be supported via all methods listed above.
 - f. All video (i.e., resolution, contrast, and so forth), data (i.e., baud rate, parity, and so forth), encoder (i.e., bandwidth, and so forth), and network (i.e., IP, subnet mask, gateway, and so forth) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet, and all other supported remote management tools.
 - g. All configurations and settings shall be downloadable/exportable in document form. As a minimum, the exported settings shall include video, network, and data settings.
- C. Failure and Reset Recovery: The recovery time of a hard or soft reset shall be less than 45 seconds.
- D. Electrical: The video encoder shall have the following characteristics:
 - 1. Power:
 - a. Nominal input voltage of 120 VAC 60 Hz.
 - b. The unit shall contain all power conversion and regulation necessary to support electronics operation.
 - 2. Power consumption: Shall not exceed 70 watts.
 - 3. All supplied video encoders shall have the same power connectors.
 - a. Each unit shall be provided with a power cable that is at least 5 feet in length.
 - b. Power cable shall be terminated with a male, 3-prong UL-listed power connector for interface with the previously stated power system.
- E. Ports: The video encoder shall have the following ports:
 - 1. Network: 10/100 Mbps RJ-45.
 - 2. Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.
 - 3. Data:
 - a. Two Electronics Industry Association (EIA)-RS232/422/485, DB-9 (Female):

- 1) These ports shall provide data pass-through for serial control (i.e., PTZ camera control).
 - 2) If EIA RS422 is not provided natively by the port, an EIA RS232-to-422 converter meeting all encoder environmental requirements shall be supplied.
 - 3) RJ-45 may be provided in place of DB 9. For each RJ-45 port, an RJ-45-to-DB-9 converter shall be supplied.
 - b. One EIA-232 DB-9 (Female):
 - 1) This port shall provide maintenance interface for local configuration.
 - 2) RJ-45 may be provided in place of DB-9. For each RJ-45 port, an RJ-45-to-DB-9 converter shall be supplied.
- F. Status Indicators:
1. The video encoder shall have the following minimum indicators:
 - a. Activity.
 - b. Power.
 - c. Video Loss.
 - d. Transmit.
 - e. Receive.
 2. Status indicators shall be LED.
- G. Physical Characteristics:
1. The video encoder shall not exceed 2-1/2 inches high by 12 inches wide by 13 inches deep.
 2. The weight shall not exceed 10 pounds.
- H. External Markings:
1. All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.
 2. The external markings shall include the product function name, model number, serial number, and manufacturer's name.
- I. Environmental:
1. The video encoder shall conform to the performance specification when operated in the following environment:
 - a. Temperature: -4 degrees F to 165 degrees F.
 - b. Humidity: 5 to 95 percent relative humidity, non-condensing.
 - c. The video encoder shall be conformal coated to prevent damage from blowing sand and dust.
 2. The video encoder shall have a minimum Mean Time Between Failures (MTBF) of 60,000 hours.
- J. MAC Address:
1. Each unit shall have a unique MAC address.

2. MAC address shall be derived from an address space of 10,000 sequential addresses.
- K. Network Management Software: All custom Management Information Bases (MIBs) required for network management shall be provided for use with third party network management software.
- L. IP Addressing: Each unit shall support and be delivered with 2 user settable IP addresses, 1 for command and control and 1 for video multicasting.

685.02.02 SUBMITTALS

- A. The following shall be submitted by the Contractor to the Contracting Agency:
 1. Acceptance Test Procedures, stand-alone and operational.
 2. Training Syllabus.
 3. Users Manual.
 4. Parts List.
 5. Description of MAC addresses scheme/space.
 6. Certifications/Statements:
 - a. Provide certification of conformance to all standards listed in this section.
 - b. Testing for compliance will be performed by an independent party.

CONSTRUCTION

685.03.01 TESTING

- A. Prior to acceptance by the Contracting Agency, the video encoder shall require testing as described below.
- B. The Contractor shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment, and any labor required from the bidder.
- C. Prior to acceptance of any video encoder, the following tests shall be performed:
 1. Stand-Alone Acceptance Test (SAT):
 - a. Using the FAST-approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST.
 - b. A vendor representative may be present during the SAT.
 - c. The Contractor will provide the vendor with a schedule of the test, including time and place.
 2. The SAT will be performed as follows:
 - a. The video encoder will be assembled and connected to power in a stand-alone configuration.
 - b. The video encoder will be powered up and allowed to initialize, boot, and run self-diagnostic tests as defined in the FAST-approved test procedures.
 - c. After the video encoder has started and initialized, any additional test procedures will be executed.

- d. After the test procedures have been executed, the video encoder will be allowed to run, uninterrupted, for a burn-in period of 72 hours.
 - e. At the end of the burn-in period, the unit will be restarted and configuration verified.
 - f. Upon completion of all test procedures, the Contractor will be notified of SAT acceptance or failure.
3. Operational Test:
- a. After successful completion of the SAT, FAST will configure and connect the video encoder to the FAST test network.
 - b. A FAST-provided CCTV assembly will be connected (video and data) to the video encoder.
 - c. Along with the video encoder, the network will also have a video decoder unit with a video monitor and a personal computer operating the video decoder software and camera control application provided by the Contracting Agency.
 - d. The following tests will be performed by FAST:
 - 1) Video Image (subjective quality acceptable to FAST).
 - 2) Serial Data Channel both point-to-point (encoder to decoder), and IP.
 - 3) User programmable parameters and functions.
 - 4) Network management.
4. While connected to the network, the video encoder shall not in any way compromise the function or functions or any other connected network device.
5. Upon completion of all the tests, the Contractor will be notified of operational test acceptance or failure. If the unit fails the test, the Contractor shall supply a new unit and the test shall be restarted.

685.03.02 WARRANTY

- A. The video encoder shall be warranted by the vendor for a minimum of 3 years.
- 1. The warranty shall be provided by the Contractor and shall guarantee the video encoder to be free from defect from assembly, fabrication, and materials.
 - 2. The FAST and Contracting Agency may exercise the option of purchasing an extended warranty for an additional 2 years utilizing the video encoder extended 2-year warranty item as indicated in Subsection [685.05.01](#), "Payment."
- B. The warranty shall be provided in writing. If the normal manufacturer's warranty extends for a longer period, the video encoder shall be warranted for that period.
- C. The warranty shall be measured from the date of receipt by the Contracting Agency.
- 1. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract.
 - 2. A report shall be submitted to FAST annually which details the status of equipment warranties.

- D. Video encoders found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs for equipment under warranty.
- E. The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:
 - 1. Software and firmware upgrades.
 - 2. Software patches.

METHOD OF MEASUREMENT

685.04.01 MEASUREMENT

- A. The video encoder shall be measured per each.
- B. The video encoder extended 2-year warranty shall be measured by lump sum.

BASIS OF PAYMENT

685.05.01 PAYMENT

- A. The accepted quantity of video encoder will be paid at the contract unit price per each, which shall be full compensation for furnishing and configuring the unit and for all labor, material, and equipment, including all necessary jumpers, required to facilitate an operational video encoder.
- B. The lump sum price for the video encoder extended 2-year warranty shall be full compensation for the extended warranty.
- C. Payment will be made under:

PAY ITEM

PAY UNIT

Video Encoder	Each
Video Encoder extended 2-year warranty	Lump sum

SECTION 688

REMOTE DATA RADIO COMMUNICATION SYSTEM

DESCRIPTION

688.01.01 GENERAL

- A. The data radio unit for installation at remote intersection traffic signal control shall be of solid state design.
 - 1. The data radio unit shall provide the capability of receiving digital signal transmissions from a master station data radio unit and returning transmissions to the master station data radio unit as required by the Freeway and Arterial System of Transportation (FAST) data radio system.
 - 2. The remote station data radio unit shall be Microwave Data System (MDS) Model MDS-9710A or approved equal and shall meet the requirements below.
- B. The remote data radio unit shall be configurable as a master station or remote radio.
 - 1. The unit shall be capable of operating as a half-duplex or simplex radio and shall support all splits in duplex frequencies.
 - 2. Full network diagnosis shall be available when operating as a master station.
 - 3. The unit shall provide high system performance and data integrity through digital signal processing.
 - 4. The data radio unit shall have the ability to communicate with any asynchronous protocol without extra software or programming.

MATERIALS / EQUIPMENT

688.02.01 FUNCTIONAL REQUIREMENTS

- A. The remote data radio units shall conform to the following general requirements:
 - 1. Supply Voltage: 10.5 VDC to 16.5 VDC.
 - 2. Tx Current: 2 amps typical at 5 watts.
 - 3. Rx Current: Less than 125 milliamps.
 - 4. Sleep Mode: 15 milliamps nominal humidity, 95 percent at 104 degrees F, non-condensing.
 - 5. Temperature Range: -22 degrees F to 140 degrees F.
 - 6. Data Rate: 9,600 bps (rf).
 - 7. Port Speed: 300 bps to 9,600 bps (rf and data) at 12.5 kHz channel spacing.
 - 8. Bit error rate: BER x .000001.
 - 9. Casing: Die cast aluminum.
 - 10. Dimensions: 2-inch by 6-inch by 8-inch maximum.
 - 11. Weight: 2.5 pounds maximum.
 - 12. Operational Modes: Asynchronous; simplex, half-duplex.

13. Data Interface: RS-232, DB-25 Female connector supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX 14, POWER, DSR, and GND.
 14. Synthesizer Range: 400 kHz sliding window, manually tunable.
 15. Current Consumption:
 - a. RF Unit Rx/Standby: 70 milliamps maximum.
 - b. RF Unit Tx: 1.6 amps nominal.
 16. TX to RX Transition Time: 3 milliseconds RSSI Squelch.
- B. Modem/Diagnostics: The remote data radio units shall conform to the following:
1. Modulation: Digital/CPFSK.
 2. CTS Delay: 0 to 255 millisecond, programmable in 1-millisecond increments.
 3. PTT Delay: 0 to 255 millisecond, programmable in 1-millisecond increments.
- C. Radio Receiver: The radio receiver shall conform to the following:
1. Type: Double conversion superheterodyne.
 2. Frequency Stability: ± 0.00015 percent (1.5 ppm).
 3. Adjacent Channel: 60 dB nominal.
 4. Sensitivity 12 dB Sinad: -117 dBm nominal.
 5. Spurious Rejection: 80 dB.
 6. Desensitization: 65 dB at 12.5 kHz and 70 dB at 25 kHz nominal.
 7. IF Selectivity: 100 dB at adjacent channel.
 8. Electronic Industry Association (EIA) Intermodulation: 65 dB.
 9. RSSI: Negative -112 dBm to -54 dBm.
 10. Squelch Opening Time: 1.5 milliseconds.
 11. Audio Outputs:
 - a. Filtered: -10 dB, 600 ohm unbalanced, adjustable.
 - b. Unfiltered: 40 mV RMS at 2 kHz Dev.
 12. Harmonic Distortion: 3 percent maximum.
- D. Radio Transmitter: The radio transmitter shall conform to the following:
1. RF Power: Adjustable between 0.5 w and 5 w at 13.6 VDC.
 2. Duty Cycle: Continuous.
 3. Time Out Timer: Programmable between 1 second and 255 seconds, or OFF.
 4. Spurious and Harmonics: -55 dBc maximum.
 5. Hum and Noise: -40 dB between 300 Hz and 3,000 Hz.
 6. Audio Inputs:
 - a. Filtered: -10 dBm, 600 ohms unbalanced, adjusted, at 2 kHz Dev.
 - b. Unfiltered: 245 mV RMS at 2.5 kHz Dev.
 7. Audio Response:

- a. Filtered: Between 1 dB and -3 dB from 5 Hz to 3,000 Hz.
 - b. Unfiltered: 1 dB and -3 dB from 5 Hz to 4,000 Hz.
- 8. Frequency Stability: ± 0.00015 percent (1.5 ppm).
- 9. Transmitter Attack Time: Less than 1 millisecond to within 100 Hz.
- 10. Carrier Power: Programmable from 0.1 watts to 5 watts.
- 11. Carrier Power Accuracy: Normal plus or minus 1.5 dB.
- 12. Output Impedance: 50 ohms.
- E. Connectors and Harnesses:
 - 1. All connectors and harnesses shall be furnished with each data radio unit. It is the supplier's responsibility to contact FAST to determine the type of connectors required.
 - 2. The remote data radio unit is for use with the FAST system.
- F. Power Requirements: The remote data radio units shall meet all specified requirements when the input power is 120 VAC plus or minus 10 VAC, and 55 Hz plus or minus 5 Hz.
- G. Antennae Requirements:
 - 1. A Yagi-type antennae with 9 dB gain shall be provided with each unit.
 - 2. The antennae shall be capable of operation within the 940 MHz to 960 MHz bandwidth.
- H. Software Requirements: All software necessary for the units to be fully functional shall be downloaded into the devices at the factory before shipment.
- I. Compliance to FAST: All equipment supplied shall conform to the requirements of FAST.

CONSTRUCTION

688.03.01 INSTALLATION

- A. The radio unit shall be installed as shown on the Drawings.

METHOD OF MEASUREMENT

688.04.01 MEASUREMENT

- A. The quantity of Remote Data Radio Unit shall be measured per each.

BASIS OF PAYMENT

688.05.01 PAYMENT

- A. The accepted quantity of Remote Data Radio Unit will be paid for at the contract unit price bid per each which shall be full compensation for providing and installing the radio unit and appurtenant equipment, measured as provided under Subsection [688.04.01](#), "Measurement," as specified, and shown on the drawings.
- B. Payment will be made under:

PAY ITEM:	PAY UNIT
Remote Data Radio Unit.....	Each

SECTION 703**BITUMINOUS MATERIALS****SCOPE****703.01.01 MATERIALS COVERED**

- A. This specification covers the quality of asphalt cement, liquid asphalt, emulsified asphalt, cationic emulsion, anionic emulsion and rubber-asphalt crack sealant.

REQUIREMENTS**703.02.01 CONTRACTOR'S RESPONSIBILITY**

- A. Bituminous material failing the test requirements of this section, including tolerances, shall be subject to Subsection [109.02](#), "Scope of Payment."

703.02.02 MATERIAL SOURCE RESPONSIBILITY

- A. Bituminous materials supplied under these specifications shall be provided from a source authorized by the Engineer and/or IQAC. The process for authorization may be obtained from the Contracting Agency's Public Works Construction Management Division.

703.02.03 SHIPPING NOTICE

- A. Shipping notices shall be mailed upon making shipment and shall contain the following information:
1. Consignee and destination,
 2. Agency contract number,
 3. Delivery point,
 4. Date shipped,
 5. Car initials or number of truck transport delivery ticket number,
 6. Type and grade of material,
 7. Quantity loaded,
 8. Loading temperature,
 9. Net quantity,
 10. Signature of shipper or authorized representative,
- B. When shipments of materials arrive on the project after normal working hours, the Contractor shall notify the Engineer sufficiently in advance to make arrangements for an inspector to be present when the material is sampled. All sampling by the Vendor or Contractor shall be performed or observed by an NAQTC certified technician.
- C. Three copies of the shipping notice shall be mailed to the Contracting Agency.

PHYSICAL PROPERTIES AND TESTS

703.03.01 REFINERY TEST REPORT

- A. Refinery test reports shall be mailed to the Engineer as soon as tests have been completed, and the report shall contain the following data:
1. Date of shipment,
 2. Car initials or number of truck transport delivery ticket number,
 3. Destination and consignee,
 4. Contracting Agency contract number (or purchase order number, if applicable),
 5. Type and grade of material,
 6. Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed and date of test),
 7. Signature of refinery's authorized representative,
- B. The certificate of compliance shall be used as a basis of permitting immediate use of the material on the job and shall represent conditional acceptance only. The certificate of compliance shall include a copy of the tests for that lot shipment.

703.03.02 ASPHALT CEMENTS

- A. Asphalt cement shall be prepared by the distillation of crude petroleum. This asphalt shall be homogeneous, free from water, and shall not foam when heated to 347 degrees F.
- B. These specifications cover the following viscosity grades: AC-2.5, AC-5, AC-10, AC-20, AC-30, AC-40 and the Superpave Performance Grades (PG) for the Southern Nevada region as listed in Table 1, Table 2, Table 2A, and Table 2B. The performance grades are to be used only when required in the Contracting Agency's Special Provisions for capital improvements or policy and procedures.

TABLE 1 - LOCATION OF BITUMINOUS GRADE USE	
Location	Viscosity Grades
Clark County Region below 6,000 feet elevation	PG 76-22CC, AC-30, or PG 64-22*
Mountain Roads at and above 6,000 feet elevation	PG 64-34CC

* Sixty (60') right of way or less

- C. The various grades set forth above shall conform to the requirements and the methods of testing shown in Table 2, Table 2A, and Table 2B.
1. Performance grade material must have been prepared from crude petroleum product.
 2. The asphalt cements shall be homogenous, free from water and shall not foam when heated to 347 degrees F.
 3. Blending of asphalt cements to produce a specified performance grade shall result in a uniform, homogenous blend with no separation.

4. Modified binders shall be blended at the source of supply and delivered as a completed mixture to the job site.
5. It shall not be transported via railroad car.
6. Only elastomeric Styrene Butadiene Styrene (SBS), Styrene-Butadiene (SB), Styrene-Butadiene Rubber (SBR), and Styrene Ethylbutylene Styrene (SEBS) rubber shall be added to the base binder asphalt cement, to produce a binder that complies with specification requirements.

703.03.03 LIQUID ASPHALTS

- A. Liquid asphalts shall consist of materials conforming to the following classifications:
 1. Rapid curing (RC) products: Paving asphalt with a penetration of approximately 85 to 100 fluxed or blended with a naphtha solvent.
 2. Medium curing (MC) products: Paving asphalt fluxed or blended with a kerosene solvent.
 3. Slow curing (SC) products: Natural crude oils or residual oils from crude asphaltic petroleum.
- B. When tested in accordance with the standard methods of AASHTO and ASTM, the grades of liquid asphalt shall conform to the requirements specified in Table 2, Table 3, and Table 4.

703.03.04 EMULSIFIED ASPHALT

- A. Emulsified asphalt for slurry seal shall conform to CQS-1h as specified in Table 6 when tested in accordance with AASHTO and ASTM.

703.03.05 SLURRY SEAL

- A. The slurry seal and its components shall conform to the requirements of Table 7 when tested in accordance with AASHTO, ASTM, and ISSA procedures.

703.03.06 MICROSURFACING

- A. The microsurfacing and its components shall conform to the requirements of Table 8 when tested in accordance with AASHTO, ASTM, and International Slurry Seal Association (ISSA) procedures.

703.03.07 POLYMER MODIFIED EMULSION MEMBRANE

- A. This material shall consist of a polymer modified asphalt emulsion. Its role is to form a water impermeable seal at the existing pavement surface and to bond the new hot mix to the existing surface. The product shall be smooth and homogeneous and conform to the requirements in Table 10.

**TABLE 2 - NEVADA TABLE 2 REQUIREMENTS
FOR ASPHALT CEMENT GRADED BY VISCOSITY AT 140°F
(Grading Based on Original Asphalt)**

Test	AASHTO Test Method	VISCOSITY GRADE					
		AC-2.5	AC-5	AC-10	AC-20	AC-30	AC-40
Viscosity at 140°F poise	T202	200 - 300	400 - 600	800 - 1,200	1,600 - 2,400	2,400 - 3,600	3,200 - 4,800
Viscosity at 275°F cSt, minimum	T201	125	175	250	300	350	400
Penetration at 77°F 100 g/5 seconds, minimum	T49	220	140	80	60	50	40
Flash point (C.O.C., °F minimum)	T48	325	350	425	450	450	450
Solubility in Trichloroethylene (percent, minimum)	T44	99	99	99	99	99	99
Ductility at 39°F 1 cm/min. cm minimum	T51	50	25	15	5	--	--
Tests on Residue From RTFO							
Loss on heating, percent maximum	T240	--	1	0.5	0.5	0.5	0.5
Viscosity at 140°F poise maximum	T202	1,000	2,000	4,000	8,000	12,000	16,000

TABLE 2A - PERFORMANCE GRADE FOR ORIGINAL MATERIALS

Test	Test Method	PG 76-22CC Modified	PG 64-34CC Modified	PG 64-22
Original Materials				
Flash Point Degrees (°C) - minimum	NDOT T716	230		
Viscosity (Brookfield) Maximum 3.0 Pas (3000cP) Test Temp. °C	ASTM D4402	135		
Dynamic Shear G*/sin α = minimum 1.0 kPa @ 10 rad/s Test Temp. °C	AASHTO T315	76	64	64
Ductility at 39.2°F, 5 cm/min. cm - minimum	NDOT T746	20	30	30
#10 Sieve Test, Pass/Fail	NDOT T730	Pass		
Solubility in Trichloroethylene, percent (%) - minimum	AASHTO T44	99		
Toughness in-lb - minimum	ASTM D 5801	150	75	N/A
Tenacity in-lb - minimum	ASTM D 5801	100	50	N/A
If T&T fails, Elastic Recovery, percent (%) - minimum	AASHTO T 301	60	60	N/A

TABLE 2B - PERFORMANCE GRADE FOR RTFO AND PAV CONDITIONING

Tests On Residue From RTFO AASHTO T-240				
Test	Test Method	PG 76-22CC Modified	PG 64-34CC Modified	PG 64-22
Ductility at 39.2°F, 1 cm/min. cm - minimum	NDOT T746	5	10	10
Mass Loss, Percent (%) - maximum	NDOT T728	0.5		
Dynamic Shear, G*/sin α = minimum 2.2 kPa @ 10 rad/s Test Temp. in °C	AASHTO T315	76	64	64
Test On Residue After PAV				
PAV, Test Temp. in °C	AASHTO R28	100	100	100
Dynamic Shear, G*/sin α = Max 5,000 kPa @ 10 rad/s Test Temp. in °C	AASHTO T315	31	19	25
BBR - Creep Stiffness, S = 300 Mpa maximum, m-value = 0.30 minimum @ 60s Test Temp. in °C	AASHTO T313	-12	-24	-12
Direct Tension, Failure Strain = 1.0% minimum @ 1.0 mm/min. Test Temp. in °C	AASHTO T314	-12	-24	-12

TABLE 3 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR RAPID CURING (RC) LIQUID ASPHALTS

Test	AASHTO Test Method	ASTM Test Method	GRADES							
			RC-70		RC-250		RC-800		RC-3000	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140°F cSt	--	D2170	70	140	250	500	800	1,600	3,000	6,000
Flash Point (Tag Open Cup), °F	T79	D1310	--	--	80	--	80	--	80	--
Distillation										
Distillate percent of total distillate to 680°F	--	--	10	--	--	--	--	--	--	--
to 437°F	T78	D402	50	--	30	--	15	--	--	--
to 500°F	--	--	70	--	60	--	45	--	25	--
to 600°F	--	--	85	--	80	--	75	--	70	--
Residue from distillation to 680°F, volume percent by difference	--	--	55	--	65	--	75	--	80	--
Test on Residue from Distillation										
Penetration, 77°F, 100g/5 seconds	T49	D5	80	120	80	120	80	120	80	120
Ductility, 77°F, cm*	T51	D113	100	--	100	--	100	--	100	--
Solubility in Trichloroethylene, %	T44	D2042	99.5	--	99.5	--	99.5	--	99.5	--
Water, %	T55	D95	--	0.2	--	0.2	--	0.2	--	0.2
GENERAL REQUIREMENT: The material shall not foam when heated to application temperature recommended by the Asphalt Institute.										
* If ductility is less than 100, material will be accepted if ductility at 60°F is 100 minimum at a pull rate of 5 cm/min										

**TABLE 4 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR
MEDIUM CURING (MC) LIQUID ASPHALTS**

Test	AASHTO Test Method	ASTM Test Method	GRADES							
			MC-70		MC-250		MC-800		MC-3000	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140°F cSt	T201	D2170	70	140	250	500	800	1,600	3,000	6,000
Flash Point (Tag Open Cup), °F	T79	D1310	100	--	150	--	150	--	150	--
Distillation										
Distillate percent of total distillate to 680°F	--	--	--	--	--	--	--	--	--	--
to 437°F	--	--	--	20	--	10	--	--	--	--
to 500°F	T78	D402	20	60	15	55	--	35	--	15
to 600°F	--	--	65	90	60	87	45	80	15	75
Residue from distillation to 680°F, volume percent by difference	--	--	55	--	67	--	75	--	80	--
Test on Residue from Distillation										
Penetration, 77°F, 100g/5 seconds	T49	D5	120	250	120	250	120	250	120	250
Ductility, 77°F, cm*	T51	D113	100	--	100	--	100	--	100	--
Solubility in Trichloroethylene, %	T44	D2042	99.5	--	99.5	--	99.5	--	99.5	--
Water, %	T55	D95	--	0.2	--	0.2	--	0.2	--	0.2
GENERAL REQUIREMENT: The material shall not foam when heated to application temperature recommended by the Asphalt Institute.										
* If penetration of residue is more than 200 and ductility at 77°F is less than 100, material will be accepted if ductility at 60°F is 100+										

**TABLE 5 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR
SLOW CURING (MC) LIQUID ASPHALTS**

Test	AASHTO Test Method	ASTM Test Method	GRADES							
			SC-70		SC-250		SC-800		SC-3000	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140°F cSt	T201	D2170	70	140	250	500	800	1,600	3,000	6,000
Flash Point (Tag Open Cup), °F*	T48	D1310	150	--	175	--	200	--	250	--
Distillation										
Total Distillate to 680°F, % by volume	T78	D402	10	30	4	20	2	12	--	5
Tests on Residue From Distillation										
Kinematic Viscosity of Distillation Residue at 140°F, stokes	T201	D2170	4	70	8	85	20	140	40	350
Ductility at 77°F, 5cm/min., cm	T51	D113	100	--	100	--	100	--	100	--
Solubility in Trichloroethylene, %	T44	D2042	99.5	--	99.5	--	99.5	--	99.5	--
Water, %	T55	D95	--	0.5	--	0.5	--	0.5	--	0.5
* Flash point by Cleveland Open Cup may be used for products having a flash point greater than 175°F										

TABLE 6 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALTS

Test	AASHTO Test Method	ASTM Test Method	Rapid Setting				Slow Setting			
			RS-1		RS-2		SS-1		SS-1h	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Test on Emulsions										
Viscosity SSF @ 77°F, sec.	T72	D88	20	100	--	--	20	100	20	100
Viscosity SSF @ 122°F, sec.	T72	D88	--	--	75	400	--	--	--	--
Settlement, 5 days, % ¹	T59	D244	--	5	--	5	--	5	--	5
Storage Stability, 1 day, % ²	T59	D244	--	1	--	1	--	1	--	1
Demulsibility, 35ml .02N, Calcium Chloride. % ³	T59	D244	60	--	60	--	--	--	--	--
Cement Mixing Test, %	T59	D244	--	--	--	--	--	2.0	--	2.0
Sieve Test, %	D59	D244	--	0.10	--	0.10	--	0.10	--	0.10
Residue by distillation, %	T59	D244	55	--	63	--	57	--	57	--
Test on Residue from Distillation Test ⁴										
Penetration @ 77°F, 100g, 5sec.	T49	D5	100	200	100	200	100	200	40	90
Ductility @ 77°F, 5m/min., cm	T51	D113	40	--	40	--	40	--	40	--
Solubility in Trichloroethylene, %	T44	D2042	97.5	--	97.5	--	97.5	--	97.5	--

¹ The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days' time, or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.

² The 24-hour 1-day storage stability test may be used instead of the 5-day settlement test.

³ The demulsibility test shall be made within 30 days from the date of shipment.

⁴ A harder base asphalt meeting current paving asphalt specifications may be specified with the provision that the test requirements on the Residue from Distillation be waived.

TABLE 7 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR CATIONIC EMULSIFIED ASPHALTS

Test	Test Method		Rapid Setting				Medium Setting				Slow Setting				Quick Setting ⁶			
	AASHTO	ASTM	CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2H		CSS-1		CSS-1h		CQS-1h	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Test on Emulsions																		
Viscosity SSF @ 77°F, sec.	T72	D88	--	--	--	--	--	--	--	--	--	--	20	100	20	100	20	100
Viscosity SSF @ 122°F, sec.	T72	D88	20	100	100	400	50	450	50	450	50	450	--	--	--	--	--	--
Settlement, 5 days, % ¹	T59	D244	--	5	--	5	--	5	--	5	--	5	--	5	--	5	--	5
Storage Stability, 1 day ²	T59	D244	--	1	--	1	--	1	--	1	--	1	--	1	--	1	--	1
Demulsibility, 35 ml 0.8% sodium dioctyl sulfosuccinate, % ³	T59	D244	40	--	40	--	--	--	--	--	--	--	--	--	--	--	--	--
Coating Ability/Water Resistance:	T59	D244	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Coating, dry aggregate			--	--	--	--	Good	--	Good	--	Good	--	--	--	--	--	--	--

Coating, after spraying			--	--	--	--	Fair	--	Fair	--	Fair	--	--	--	--	--	--
Coating, wet aggregate			--	--	--	--	Fair	--	Fair	--	Fair	--	--	--	--	--	--
Coating, after spraying			--	--	--	--	Fair	--	Fair	--	Fair	--	--	--	--	--	--
Particle Charge Test	T59	D244	Positive		Positive		Positive		Positive		Positive		Positive ⁵		Positive ⁵		Positive
Sieve Test, %	T59	D244	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	0.10
Cement Mixing Test, %	T59	D244	--	--	--	--	--	--	--	--	--	--	--	2.0	--	2.0	--
Distillation																	
Oil Distillate by volume of emulsion, %	T59	D244	--	3	--	3	--	20	--	12	--	12	--	--	--	--	--
Residue, %	T59	D244	60	--	65	--	60	--	65	--	65	--	57	--	57	--	60
Tests on Residue from Distillate Test⁴																	
Penetration, 77°F, 100g, 5sec.	T49	D5	100	250	100	250	100	250	100	250	40	90	100	250	40	90	45
Ductility, 77°F, 5cm/min., cm	T51	D113	40	--	40	--	40	--	40	--	40	--	40	--	40	--	40
Solubility in Trichloroethylene, %	T44	D2042	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5

¹ The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days' time, or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.

² The 24-hour 1-day storage stability test may be used instead of the 5-day settlement test.

³ The demulsibility test shall be made within 30 days from the date of shipment.

⁴ A harder base asphalt meeting current paving asphalt specifications may be specified with the provision that the test requirements on the Residue from Distillation be waived.

⁵ Must meet a PH requirement of 6.7 maximum (ASTM E70) if the Particle Charge Test result is inconclusive.

⁶ Does not apply to polymer modified emulsion.

TABLE 8 SPECIFICATION FOR SLURRY SEAL MIX

TEST ON MIXTURE	TEST METHOD	REQUIREMENTS
Residual Asphalt, % of dry wt. of aggregate	--	7.5 - 13.5
Consistency, flow	ASTM D3910/ISSA T106	2 - 3 cm
Wet Cohesion, 30-minute set	ISSA T139	12 -13 kg/cm
Wet Cohesion, 60-minute set	ISSA T139	20 - 21 kg/cm
Set Time, 30 minutes	ASTM D3910	Negative
Excess Asphalt by LWT and Sand Adhesion	ASTM T109	50 g/ft ² max.
Wet Stripping, % coating	ASTM T114	90 min.
Wet track Abrasion (6-day soak)	ASTM D3910/ISSA T100	75 g/ft ² max.
Wet track Abrasion (1-hour soak)	ASTM D3910/ISSA T100	75 g/ft ² max.
System Compatibility	ISSA T115	Pass
Mix time @ 77°F	ASTM D3910/ISSA T113	Controllable to 180 sec. minimum

TABLE 9 SPECIFICATION FOR MICRO-SURFACING MIX

TEST ON MIXTURE	TEST METHOD	REQUIREMENTS
Residual Asphalt, % of dry wt. of aggregate	--	5.5 - 9.5
Wet Cohesion, 30-minute set	ISSA T139	12 kg/cm

TABLE 9 SPECIFICATION FOR MICRO-SURFACING MIX

TEST ON MIXTURE	TEST METHOD	REQUIREMENTS
Wet Cohesion, 60-minute set	ISSA T139	20 kg/cm
Excess Asphalt by LWT and Sand Adhesion	ISSA T109	50 g/ft ² max.
Wet Stripping, % coating	ISSA T114	90 min.
Wet track Abrasion (6-day soak)	ASTM D3910/ISSA T100	75 g/ft ² max.
Wet track Abrasion (1-hour soak)	ASTM D3910/ISSA T100	50 g/ft ² max.
Mix time @ 77°F	ASTM D3910/ISSA T113	Controllable to 120 sec minimum
Mix time @ 104°F	ASTM D3910/ISSA T113	Controllable to 120 sec minimum
Lateral Displacement	ISSA T147	5% max.
Classification Compatibility	ISSA T144	(AAA, BAA) 11 grade points minimum

Table 10 - SPECIFICATION FOR POLYMER MODIFIED EMULSION MEMBRANE

TEST ON EMULSION	Method	Min.	Max.
Viscosity @ 77°F, SSF	ASTM D88	20	100
Sieve Test, %	AASHTO T59	--	0.05
24-Hour Storage Stability, % ¹	AASHTO T59	--	1
Residue from Distillation @ 400°F, %	AASHTO T59	63	--
Oil portion from distillation ml of oil per 100 g emulsion ²	AASHTO T59	63	--
TEST ON RESIDUE FROM DISTILLATION			
Solubility in TCE, % ³	AASHTO T44	97.5	--
Elastic Recovery @ 50°F, % ⁴	AASHTO T301	58	--
Penetration @ 77°F, 100 g, 5 sec, dmm	AASHTO T49	60	150

¹ After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.

² ASTM D244 with modifications to include a 400°F ± 10°F maximum temperature to be held for a period of 15 minutes. Alternatively, ASTM D244 (Sections 21-27) Residue by Evaporation may be utilized as a surrogate procedure. However, Residue by Distillation is preferred and shall be used as the reference procedure.

³ ASTM D5546, "Standard Test Method for Solubility of Asphalt Binders in Toluene by Centrifuge," may be substituted where polymers block the filter in Method D2042.

⁴ ASTM D5976, "Standard Specification for Type I Polymer Modified Asphalt Cement for Use in Pavement Construction," Section 6.2 with exception that the elongation is 20 cm and the test temperature is 50°F.

SECTION 704

BASE AGGREGATES

SCOPE

704.01.01 MATERIALS COVERED

- A. This specification covers the quality and size of mineral materials used in base courses, trench backfill, or other construction locations.
- B. The term Source shall mean any of the following:
 - 1. A permanent commercial location.
 - 2. Contractor manufactured material either commercial or on-site.

704.01.02 REFERENCE CODES AND STANDARDS:

- A. Related Interagency Quality Assurance Committee (IQAC) procedures at:
www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx (IQAC website)

REQUIREMENTS

704.02.01 GENERAL

- A. The mineral aggregate shall be the crushed and screened product from approved aggregate deposits, except that Type I aggregate base need not be crushed. The Engineer reserves the right to prohibit the use of aggregates from any source when:
 - 1. The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.
 - 2. The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency.
- B. The mineral aggregate shall be clean, hard, durable, free from any frozen lumps, deleterious matter, and harmful adherent coatings. Crushed Portland cement concrete and asphaltic concrete pavement will be permitted, subject to the requirements of these specifications. No materials subject to regulation as hazardous wastes as defined in the Nevada Administrative Code 444.8565 shall be allowed.

704.02.02 IQAC SOURCE QUALIFICATION

- A. For expediting of material source and type approvals, a listing of qualified materials has been provided on the IQAC website.
- B. Any listed material is considered qualified for use without a material testing submittal. However, this does not relieve the Contractor of project testing of the material as required in these specifications.
- C. The IQAC posted materials indicated in Table 1 are subject to reapproval ""annually for continued posting on the IQAC website. The procedure is annotated in Subsection [704.04.02](#), "IQAC Annual Material Prequalification."

Table 1 – IQAC Materials that Require Annual Qualification

Type II Aggregate Base
Type II Controlled Low Strength Material (CLSM)

Table 2 – Materials that Require 6-Month Qualification

Type II blended with recycled Portland Cement Concrete
--

704.02.03 DEFICIENCIES

- A. If the product of a deposit is deficient in material passing the No. 16 sieve, filler from other approved deposits may be added at the crushing and screening plants. This is not to be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS**704.03.01 PLASTIC LIMITS**

- A. When specified, aggregates shall conform to the applicable requirements of the following table:

Table 3 – Plastic Limits

Percentage by Weight Passing 200 Sieve	Plasticity Index Maximum
0.1 to 3.0	15
3.1 to 4.0	12
4.1 to 5.0	9
5.1 to 8.0	6
8.1 to 11.0	4
11.1 to 15.0	3

704.03.02 DRAIN BACKFILL

- A. This aggregate shall conform to the following requirements:

Table 4 – Drain Rock Gradation Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve		
	3-Inch Size	2-Inch Size	3/4-Inch Size
3-Inch	100	--	--
2-Inch	90-100	100	--
1-1/2-Inch	70-100	95-100	--
3/4-Inch	0-50	50-100	100
1/2-Inch	--	--	95-100
3/8-Inch	0-10	0-55	70-100
No. 4	--	0-25	0-70
No. 8	0-5	0-15	--
No. 200	0-3	0-3	0-3

- B. Unless otherwise specified in the contract documents, the Contractor may use any of the sizes.

Table 5 – Drain Backfill Durability Acceptance Limits

Source Requirement Test	3-Inch Size	2-Inch Size	3/4-Inch Size
Percentage of Wear (500 Rev.)	45% Maximum	45% Maximum	45% Maximum

704.03.03 TYPE I AGGREGATE BASE

A. This aggregate shall conform to the following requirements:

Table 6 – Type I Gradation Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve	
	3-Inch Size	2-Inch Size
3-Inch	100	--
2-Inch	90-100	100
1-1/2-Inch	--	95-100
1-Inch	--	70-90
No. 4	30-65	30-65
No. 16	15-40	15-40
No. 200	2-12	2-12

Table 7 – Type I Acceptance Limits

Project Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 6
Sampling Aggregate from Calibrated Conveyor stream or belt cut ¹	AASHTO T2	--
Plasticity Index	AASHTO T90 ²	Table 3
Liquid Limit	AASHTO T89	35 Maximum
Resistance (R Value)	ASTM D2844	60 Minimum
Percentage of Wear (500 Rev.)	AASHTO T96	45% Maximum

704.03.04 TYPE II AGGREGATE BASE

A. This aggregate shall conform to the following requirements:

Table 8 – Type II Gradation Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve
1-Inch	100
3/4-Inch	90-100
No. 4	35-65
No. 16	15-40
No. 200	2-10

¹ Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every 3 months and record attached to sample document.

² Test specimens shall be prepared following the dry preparation procedure AASHTO T87.

Table 9 – Type II Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 8
Sampling Aggregate from Calibrated Conveyor stream or belt cut ³	AASHTO T2	--
Fractured Faces	Nev. T230	70% Minimum
Plasticity Index	AASHTO T90 ⁴	Table 3
Liquid Limit	AASHTO T89	35 Maximum
Resistance (R Value) or Resilient Modulus	ASTM D2844	78 Minimum for road base
	AASHTO T307	35,000 psi minimum for road base
Percentage of Wear (500 Rev.)	AASHTO T96	45% Maximum
Total Available Water Soluble Sulfates ⁵	AWWA 3500-NaD AWWA 4550 E	Less than 0.3% by dry weight of soil.

- B. Type II Plantmix Aggregate as specified in Subsection [705.03.01](#), "Plantmix and Roadmix Bituminous Base and Surface Aggregate, Types Two Fine and Coarse and Three," may be used in lieu of Type II Base Aggregate as specified above.

704.03.05 TYPE III AGGREGATE

- A. The soluble sulfate content shall not exceed 0.3 percent by dry weight of soil. The mineral shall be clean, hard, durable, free from any frozen lumps, deleterious matter, and harmful coatings. In addition thereto, the material shall conform to the gradation requirements of Type II aggregate base in accordance with Subsection [704.03.04](#), "Type II Aggregate Base," with the following property testing:

Table 10 – Type III Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 8
Sampling Aggregate from Calibrated Conveyor stream of belt cut ⁶	AASHTO T2	--
Plasticity Index	AASHTO T 90 ⁷	Table 3
Liquid Limit	AASHTO T 89	35 Maximum
No. 200 Sieve	AASHTO T 27	2-15%
Total Available Water Soluble Sulfates ⁸	AWWA 3500-NaD AWWA 4550 E	Less than 0.3% by dry weight of soil

704.03.06 CRUSHED ROCK

- A. Crushed rock shall be the product from approved aggregate deposits and shall only be used as directed by the Contracting Agency. The mineral aggregate shall be clean, hard,

³ Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every 3 months and record attached to sample document.

⁴ Test specimens shall be prepared following the dry preparation procedure AASHTO T87.

⁵ Required only for placement around waterline pipe.

⁶ Sampling from a stockpile permitted only after approval of the Engineer.

⁷ Test specimens shall be prepared following the dry preparation procedure AASHTO T87.

⁸ Required only for placement around waterline pipe.

durable, free from any frozen lumps, deleterious matter, and harmful coatings. In addition thereto, the material shall conform to the following gradation requirements:

Table 11 – Crushed Rock Gradation Acceptance Limits

Sieve Sizes	Percentage of Weight Passing
3/8-Inch	100
No. 4	20-80
No. 200	0-15

Table 12 – Crushed Rock Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T 27	Table 11
Sampling Aggregate From Calibrated Conveyor stream of belt cut ⁹	AASHTO T 2	-----
Fractured Faces	Nev. T 230	90% Minimum
Plasticity Index	AASHTO T 90 ¹⁰	Table 3
Liquid Limit	AASHTO T 89	35 Maximum
Percentage of Wear (500 Rev.)	AASHTO T 96	45% Maximum
Total Available Water Soluble Sulfates ¹¹	AWWA 3500-NaD AWWA 4550 E	Less than 0.3% by dry weight of soil

704.03.07 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. CLSM shall consist of a low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregate, water, and chemical admixtures. CLSM shall have a design compressive strength at an age of 28 days within the ranges required below for the specified class:
1. Class I - (50 to 150 psi): Specified where the maximum strength is of primary concern due to the desire to have material that can be excavated in the future with relative ease.
 2. Class II – (100 to 300 psi): Specified where the minimum strength is of primary concern for pipe support.
 3. Class Special (as shown in project specifications or drawings): Specified where project unique criteria, such as erosion control, are the primary concern.
 4. Class I and II CLSM:
 - a. The mix shall result in a product having a slump in the range of 6 to 10 inches at the time of placement.
 - b. The Source of Contractor shall submit a mix design for approval by the Engineer prior to placement.
 - c. The mix design shall be supported by laboratory test data verifying the potential of the mix to comply with the requirements for these specifications.

⁹ Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every 3 months and record attached to sample document.

¹⁰ Test specimens shall be prepared following the dry preparation procedure AASHTO T87.

¹¹ Required only for placement around waterline pipe.

- B. CLSM shall be proportioned in general compliance with the methods outlined in ACI 211.1-91, reapproved 1997, "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete." The following materials shall be used:
1. Cement shall meet the requirements of Section [701](#), "Hydraulic Cement." Type V cement shall be used unless otherwise specified.
 2. Fly ash shall meet the requirements of Section [729](#), "Fly Ash." Fly ash not meeting the requirements of Section [729](#), "Fly Ash," may be used if prior testing indicates to the satisfaction of the Engineer the ability of the CLSM with this fly ash to meet these specifications.
 3. Water shall meet the requirements of Section [722](#), "Water."
 4. Aggregates shall have 100 percent by total weight of the aggregate passing the 1 inch screen and 15 percent or less passing the No. 200 sieve. The aggregate shall meet the plastic limits requirements of Subsection [704.03.01](#), "Plastic Limits."
 5. Chemical admixtures shall meet the requirements of Subsection [702.03.02](#), "Air-Entraining Admixtures," and Subsection [702.03.03](#), "Admixtures Other Than Air-Entraining."
 - a. Other admixtures specifically approved for CLSM may be used.
 - b. All materials proportions shall be measured and the CLSM mixed in accordance with Section [501](#), "Portland Cement Concrete."
 - c. Other proportion measuring and CLSM mixing systems are acceptable, if control can be demonstrated to be satisfactory to the Engineer.
 - d. These other methods include continuous feed, volumetric measurement of proportions, and pug mill and continuous mixing plants.
- C. If the CLSM mix does not produce a flowable consistency or exhibits excessive bleeding, the mix shall be adjusted.
1. Excessive bleeding is considered to occur when water flows from the CLSM in a manner that causes disturbance or displacement of the exposed surface of the CLSM.
 2. Mix adjustments shall include, but not be limited to: aggregate gradation, cementitious material content, admixtures, water content, or a combination of adjustments.
- D. The testing procedures for approval of CLSM mix designs by the IQAC or if required in the contract special provisions shall be as follows:
1. The material Source, which may be the Contractor, shall cast one set of six each 4-inch diameter by 8-inch high specimens in split cylinders.
 2. No rodding method shall be used for the placement of the CLSM into the cylinders.
 3. All field curing and environmental protection shall conform to AASHTO T23, "Test Methods for Making and Curing Concrete Test Specimens in the Field."
 4. The cast specimens shall then be laboratory-cured in a 100 percent humidity, temperature-controlled concrete cure room (cure tanks shall not be used).
 5. Compressive strength testing shall be performed in accordance with AASHTO T22 and T23 with samples from each set at the ages of 7, 28, and 90 days.

6. A report of the results shall be submitted to the Engineer.
- E. Class Special: The compressive strength testing procedures shall be as specified in the project specifications or on the project drawings.
- F. **Bonded Aggregate Fill (BAF):**
 1. This material is a crushed rock-cement slurry consistency.
 2. BAF may be used only with the prior approval of the Engineer.
 3. The material Source shall have it designed under the responsible charge of a Nevada PE, and the mix shall consist of a gap-graded 1/2-inch maximum nominal size crushed gravel with a 1-sack minimum Type V cement and water slurry.
 4. The material shall be plant mixed and placed from a truck.
 5. Due to the gap-graded nature of the material, it shall not be used where water drainage is an issue and in all cases shall use dams as specified in Subsection [208.03.16](#), "Drain Backfill."
 6. This procedure does not require concrete cylinder break testing; however, it does require a visual inspection and shall be documented in a report to the Engineer summarizing the inspection to be performed as follows:
 - a. After the first batch is placed and initially cured, excavate to the bottom of the pipe or structure.
 - b. If a self-supporting vertical face is maintained, the material is functioning properly.

704.03.08 AGGREGATE FOR PORTLAND CEMENT TREATED BASE

- A. This aggregate shall conform to the following requirements:

**Table 13 – Portland Cement Treated Base Gradation
Acceptance Limits**

Sieve Sizes	Percentage by Dry Weight Passing Sieve
3-Inch	100
2-Inch	90-100
No. 4	35-75
No. 200	20

Table 14 – Portland Cement Treated Base Acceptance Limits

Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 13
Sampling Aggregate from Calibrated Conveyor stream or belt cut ¹²	AASHTO T2	1/1000 Tons per day or portion thereof
Percentage of Wear (500 Rev.)	AASHTO T96	45% Maximum

- B. Aggregate for cement or lime treated bases will be sampled as follows:
 1. Where the material is being mixed at a stationary plant, samples will be taken from the conveyors just prior to delivery to the mixer and prior to adding lime or cement.

¹² Sampling from a stockpile permitted only after approval of the Engineer. The conveyor device shall be calibrated every 3 months and record attached to sample document.

2. Where material is being mixed on the roadbed, samples will be taken after the material has been placed on the roadbed and processed and prior to adding cement or lime.

704.03.09 SHOULDERING MATERIAL

- A. This aggregate shall conform to the following requirements:

Table 15 – Shouldering Material Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve
1-Inch	100
3/4-Inch	90-100
No. 4	35-65
No. 16	15-40
No. 200	2-6

SOURCE QUALITY CONTROL TESTING

704.04.01 GENERAL

- A. There are 2 testing aspects to Source material acceptance.
 1. Testing by the Source for annual posting on the IQAC website of qualified materials.
 2. Contractor project quality control Source testing for non-qualified materials.
- B. The acceptance of the Source material shall be at the production plant while the acceptance of the Contractor-placed material is at the project site.
- C. Any laboratory submitting to an agency shall be R-18 AASHTO accredited in the appropriate test method in accordance with Table 16, "Source Quality Control Testing Requirements," where applicable and testing reviewed and stamped by a Nevada professional engineer who has responsible charge of the work. The use of a professional engineer by the Source could be the Source staff engineer or third party, but the professional engineer must have responsible charge of the testing and/or inspection.

704.04.02 IQAC ANNUAL MATERIAL PREQUALIFICATION

- A. Each individual location or "pit" shall be referred to as a "Source." The responsibility for testing and inspection is the material Source. Material shall be tested, inspected, and certified in accordance with Table 16 "Source Quality Control Testing Requirements." The Source shall submit to the IQAC agency engineer assigned for that Source. The reviewing agency is listed on the IQAC website page next to the Source material.
- B. Test data shall be included with the certifying document.
- C. The maximum qualification period is 1 year, or 6 months for aggregate blended with crushed concrete. The entire qualification process shall be completed, in accordance with the sections above, prior to the first day of April, or for aggregates blended with crushed concrete, the first day of April and the first day of October of each year. This includes, but is not limited to, submittal, agency review, all required retesting, and qualification from the IQAC member.

704.04.03 NON-PREQUALIFIED MATERIALS

- A. If the material is not posted on the IQAC web page, the Source may elect to submit non-prequalified material to the Engineer for approval prior to use that complies with the above noted specification and shall have been tested within 60 days of the intended use.

704.04.04 SUBMITTAL

- A. All tests specified in this section shall be performed.
 - 1. The report(s) shall include any graphical representation of plotted data such as the R-value or the Proctor value(s) along with the pit name and location.
 - 2. The most current ASTM, AASHTO, NDOT, and AWWA methods shall be used when performing the tests.
- B. All samples shall be "cut" from the "belt." When circumstances do not allow for sampling during production, the Source shall coordinate with the Engineer to identify an alternative plan for sampling.
- C. IQAC Annual Submittal
 - 1. For the purposes of IQAC submittal, the Engineer is the IQAC reviewing agency as noted on the IQAC web page.
 - 2. For the annual submittal by the supplier, the material to be approved for use as aggregate shall be obtained and "split" by an AASHTO accredited laboratory with the Engineer present at the time the sample is obtained with the sample large enough for a full suite of testing for the Source and Engineer.
 - 3. The Engineer shall be notified a minimum of 48 hours prior to obtaining the sample.
 - 4. If the Engineer is not present during the sampling of the material, the results for that sample will not be accepted.
 - 5. Sampling shall be performed during normal working hours for the Engineer.
 - 6. If the Source laboratory results are in compliance with the above noted specifications, Source shall submit the test report to the Engineer within 21 days of sampling requesting the review and approval of the materials for the proposed use of the material.
 - 7. Notification by the Source of samples not in compliance with the above noted specifications is requested but not required. Samples without notification or a qualification submittal within the 21-day period will be assumed by the IQAC to be outside the above noted specifications.
 - 8. The agency Engineer for a particular pit may accommodate minor adjustments for "tuning" of an operation. This courtesy shall not be extended during the qualification process.
- D. Non-prequalified materials (materials not posted on the IQAC list)
 - 1. The material to be approved for use as aggregate shall be obtained and "split" by an AASHTO accredited laboratory with the Engineer present at the time the sample is obtained with the sample large enough for a full suite of testing for the Source and Engineer.
 - a. The Engineer shall be notified a minimum of 48 hours prior to obtaining the sample.
 - b. If the Engineer is not present during the sampling of the material, the results for that sample will not be accepted.
 - c. Sampling shall be performed during normal working hours for the Engineer.

- d. If the Source laboratory results are in compliance with the above noted specifications, the Source shall submit the test report to the Engineer within 21 days of sampling with a letter requesting the review and approval of the materials report for the proposed use of the material.
2. Notification by the Source of samples not in compliance with the above noted specifications is requested but not required.
 - a. Samples without notification or a qualification submittal within the 21-day period will be assumed by the IQAC to be outside the above noted specifications.
 - b. The Source shall submit the material test report to the Engineer no earlier than 60 days and no later than 14 days prior to use.
3. The qualification is for one project only.

704.04.05 REPORT FORMAT

- A. The report shall be prepared and stamped by, or under the direction of, a professional engineer registered in the state of Nevada. The report shall be on the standard IQAC¹³ form and shall include the pit name and location. The report shall include the following:
 1. Recommendation by the Source Professional Engineer.
 2. The testing results in accordance with the appropriate Table 16, "Source Quality Control Testing Requirements," test methods and reporting requirements, along with any graphs and charts.
- B. When "no exceptions" are taken, a conditional posting on the web site will be provided by the IQAC within 10 days of the receipt of the submittal.
- C. Discrepancies between test results will be reviewed on a case-by-case basis. The Engineer will notify the aggregate producer of substantial test variations within 10 days of receipt of the qualification submittal.

704.04.06 SAMPLING AND TESTING

- A. When the Contractor/Material Source or Engineer acquires aggregate samples at an aggregate production plant, the plant shall provide a calibrated mechanical means for obtaining samples.
 1. If a mechanical means is not provided, a belt cut from a stopped conveyor will be required.
 2. Any mechanical sampling device shall be approved by the Engineer prior to starting the respective phase of the project, or shall have been approved as part of a prior plant inspection by the Engineer or the Engineer's representative.
 3. The sampling device shall be so constructed to provide for simultaneous "cutting" of the entire section of material being discharged or conveyed, and so constructed that small representative samples may be taken frequently and these samples combined to form the complete sample.
 4. The reference method for the mechanical procedure shall be a "belt cut" sample taken from a stopped conveyor belt.

¹³ The form is on the IQAC website, or use an Agency approved form

5. Samples of the finished product of the plant shall be obtained prior to or as the material leaves the conveyor belt for the bin or stockpile.
- B. Test results run from samples taken will be furnished to the Engineer by the Contractor or the Contractor's representative. The results of such tests shall not be the basis for final acceptance of the material.
- C. Sampling for final acceptance of materials will be as required in the appropriate USS sections and in general shall comply with the AASHTO requirements, where applicable, and with any exception to the method(s) listed on the IQAC website.

Table 16 – Source Quality Control Testing Requirements¹⁴

Spec Section	Description	Item	Reference Specification and/or Test Procedure	Frequency
704.03.02 , 704.03.03 , 704.03.04 , 704.03.08	Drain Rock	Submittal	IQAC and/or Agency Requirements	Annually for IQAC Source Approval OR per project
	Type I, Type II Aggregate	Sampling from calibrated conveyor stream or belt cut	AASHTO T2	1/day at plant
	Cement treated base	Sieve Analysis	AASHTO T11 & T27	1/day at plant
		Percentage of Wear (500 Rev.)	AASHTO T96	Annually for Source Approval OR per project
704.03.04 , 704.03.05 , 704.03.06	Drain rock, Type II, and Type III aggregate around water pipe	Total Available Water Soluble Sulfates ¹⁵	AWWA 3500-NaD AWWA 4550 E	1/month at plant
704.03.03 , 704.03.04	Type I and Type II Aggregate	Plasticity Index	AASHTO T90 ¹⁶	1/day at plant
		Liquid Limit	AASHTO T89	1/day at plant
		Resistance (R Value) or Resilient Modulus	ASTM D2844	Annually for IQAC Source Qualification OR per project
			AASHTO T307	Annually for IQAC Source Qualification OR per project
704.03.07	CLSM	Mix Design	USS 704.03.07	Annually for IQAC Source Qualification OR per project
		Compressive Strength	USS 208.02.07 & AASHTO T22, T23	Annually for IQAC Source Qualification OR per project
	CLSM-BAF	Visual Inspection Report	USS 208.02.07 Split cylinders	Annually for IQAC Source Qualification OR per project

¹⁴ Review the IQAC website for any exceptions to the listed test methods.

¹⁵ Required only for placement around waterline pipe

¹⁶ Test specimens shall be prepared following the dry preparation procedure AASHTO T87

SECTION 705

AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 MATERIALS COVERED

- A. This specification covers the quality and size of local mineral materials and commercial mineral fillers used in bituminous base and surface courses.

REQUIREMENTS

705.02.01 GENERAL

- A. The mineral aggregate shall be the crushed and screened product of approved deposits.
- B. The Engineer reserves the right to prohibit the use of aggregates from any source when:
 - 1. The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to these specifications; or
 - 2. The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency; or
 - 3. The maximum allowable water absorption of either coarse or fine aggregate exceeds 2.5 percent when tested in accordance with ASTM C127 (coarse aggregate) and ASTM C128 (fine aggregate).
- C. The mineral aggregate shall be clean, hard, durable, and free from frozen lumps, deleterious matter, and harmful adherent coatings.
- D. When producing plantmix aggregate, all natural fines passing the No. 4 sieve shall be screened from the coarse aggregate and may be reintroduced into the mix at a rate not to exceed 20 percent by dry weight of the combined aggregates.
- E. The natural fines may be used only when all applicable mix design criteria have been met.

705.02.02 DEFICIENCIES

- A. If the product of any deposit is deficient in the fraction passing the No. 50 sieve, additional filler from other approved deposits meeting the physical requirements may be added.
- B. The added material shall be fed to the drier in a uniform manner from a separate stockpile.
- C. If the added material is a commercial mineral filler, it shall be uniformly fed directly to the plant. This shall not be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS

705.03.01 PLANTMIX AND ROADMIX BITUMINOUS BASE AND SURFACE AGGREGATE, TYPES TWO FINE AND COARSE AND THREE

- A. The aggregate shall conform to this subsection.
- B. Test specimens shall be prepared following dry preparation procedure described in ASTM D4318, Section 10.2 through Section 10.2.5.

TABLE 1 – PLANTMIX AND ROADMIX AGGREGATE GRADATION

Sieve Sizes	Percent By Weight Passing Sieve		
	Type 2 Coarse Arterials	Type 2 Fine Residential/Collector	Type 3
1-Inch	100	100	--
3/4-Inch	84-97	90-100	--
1/2-Inch	66-82	78-94	100
3/8-Inch	56-72	68-84	90-100
No. 4	35-50	50-65	55-85
No. 8	23-38	30-49	32-67
No. 50	5-19	7-25	7-27
No. 200	2-7	2-9	2-10

TABLE 2 – PLANTMIX AND ROADMIX AGGREGATE SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Fractured Faces	NEV. T230	Traffic Category I: 90% Minimum (2 fractures minimum) 95% Minimum (1 fracture minimum)
		Traffic Category II: 35% Minimum (2 Fractures minimum)
Plasticity Index	ASTM D4318	All Traffic Categories: 6 Maximum
Liquid Limit	ASTM D4318	All Traffic Categories: 35 Maximum
Methylene Blue Test	AASHTO TP57	10 Maximum
Fine Aggregate Angularity	AASHTO T33	Traffic Category I: 45%

Source Tests	Test Methods	Requirements
Stripping Test	ASTM D1664	Satisfactory
Percentage of Wear (500 Rev.)	ASTM C131	All Traffic Categories: 35% Maximum
Elongation @ 5:1	ASTM D4791	Traffic Category I: 10% Maximum
Soundness Test	ASTM C88	All Traffic Categories: 8% Maximum
Deleterious Materials	ASTM C142	All Traffic Categories: 0.3% Maximum

705.03.02 BLANK**705.03.03 PLANTMIX BITUMINOUS OPEN-GRADED SURFACE AGGREGATE**

A. The aggregate shall conform to the following requirements:

TABLE 3 – OPEN GRADE AGGREGATE GRADATION

Sieve Sizes	Percentage By Weight Passing Sieve
1/2-Inch	100
3/8-Inch	90-100
No. 4	35-55
No. 8	5-15
No. 200	0-3

TABLE 4 – OPEN GRADE AGGREGATE SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Fractured Faces	NEV. T230	90% Minimum (2 fractures minimum)

Source Tests	Test Methods	Requirements
Percentage of Wear (500 Rev.).	ASTM C131	37% Maximum

705.03.04 COMMERCIAL MINERAL FILLER

- A. Commercial mineral filler shall conform to ASTM C977 for quicklime, ASTM C1097 for hydrated lime, and ASTM D3910 and ASTM D242 for slurry seal and microsurfacing.
- B. Sampling of the mineral aggregate and mineral filler shall conform to AASHTO T2/ASTM D75 methods.
1. All aggregate shall be from the same source.
 2. No field blending will be allowed.
- C. When tested according to the following tests, the mineral aggregate shall meet the following requirements:

TABLE 5 - MINERAL FILLER AGGREGATE GRADATION

Property	Test Method	Specification
Sand Equivalent	AASHTO T176/ ASTM D2419	50 Minimum for Slurry and 65 Minimum for Microsurfacing
Plasticity Index	ASTM D4318	NP
Soundness, %	AASHTO T104/ ASTM C88	15 Maximum (using Na_2SO_4)
Abrasion Resistance, %	AASHTO T96/ ASTM C131	30 Maximum. Abrasion test shall be run on the aggregate before it is crushed.

- D. When tested in accordance with AASHTO T27, AASHTO T11, ASTM C136, and ASTM C117, the mineral aggregate with mineral filler shall conform to the gradations indicated below. Percentage passing shall not vary from the high limit to the low limit on any 2 consecutive sieves.

705.03.05 SCREENINGS

- A. The screenings shall conform to the following requirements:

TABLE 6 – SCREENINGS GRADATION

Sieve Sizes	Percentage By Weight Passing Sieve	
	1/2-Inch	3/8-Inch
1/2-Inch	100	--
3/8-Inch	90-100	100
No. 4	15-35	20-45
No. 16	0-4	0-6
No. 200	0-2	0-2

TABLE 7 SCREENINGS SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Fractured Faces	NEV. T230	90% Minimum (2 fractures minimum)

Source Tests	Test Methods	Requirements
Percentage of Wear (500 Rev.)	ASTM C131	37% Maximum

705.03.06 SAND BLOTTER

A. The sand shall conform to the following requirements:

TABLE 8 – SAND BLOTTER GRADATION

Sieve Sizes	Percentage By Weight Passing Sieve
1/2-Inch	100
No. 4	90-100
No. 16	30-75
No. 200	0-12

TABLE 9 – SAND BLOTTER SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Organic Impurities	ASTM C40	--

TABLE 10 - ISSA, TYPE I GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8-Inch	100	0
No. 4	100	0
No. 8	90-100	±5%
No. 16	65-90	±3%
No. 30	40-65	±3%
No. 50	25-42	±3%
No. 100	15-30	±2%
No. 200	10-20	±2%

TABLE 11 - ISSA, TYPE II GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8-Inch	100	0
No. 4	90-100	±5%
No. 8	65-90	±5%

TABLE 11 - ISSA, TYPE II GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
No. 16	45-70	±3%
No. 30	30-50	±3%
No. 50	18-30	±3%
No. 100	10-21	±2%
No. 200	5-15	±2%

TABLE 12 - ISSA, TYPE III GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8-Inch	100	0
No. 4	70-90	±5%
No. 8	45-70	±5%
No. 16	28-50	±3%
No. 30	19-34	±3%
No. 50	12-25	±3%
No. 100	7-18	±2%
No. 200	7-15	±2%

705.03.07 SET CONTROL ADDITIVES

- A. The type and quantity of additives in slurry seal and microsurfacing mix shall be determined by the material mix design and conform to the applicable sections of ASTM D3910 and ISSA T102.

705.03.08 PLANTMIX AND ROADMIX ASPHALT CONCRETE SURFACE COURSE UTACS TYPE S1 THROUGH S3

- A. The Ultrathin Asphalt Concrete Surface (UTACS) shall use one of the gradation types listed below as required by the Engineer.

Table 13 - Ultrathin Asphalt Concrete Surface (UTACS) Gradations

Sieve Size	Type S1	Type S2	Type S3	Tolerance
3/4-Inch ¹	--	--	100	--
1/2-Inch	--	100	85-100	±6
3/8-Inch	100	85-100	60-80	±6
No. 4	40-55	22-40	22-38	±4
No. 8	19-32	19-32	19-32	±4
No. 16	15-25	15-23	15-23	±3
No. 30	10-18	10-18	10-18	±3
No. 50	8-13	8-13	8-13	±3
No. 100	6-10	6-10	6-10	±3
No. 200	4-7	4-7	4-7	±2

- B. Coarse aggregate testing shall comply with Table 2. Coarse aggregate is defined as aggregate that is retained on and above the No. 4 sieve.

Table 14 UTACS Coarse Aggregate Specifications

Tests	Method	Limit
Los Angeles abrasion value, % loss	AASHTO T96	35 Maximum
Soundness, % loss	AASHTO T104	18 Maximum
Magnesium Sulfate or Sodium Sulfate	AASHTO T104	12 Maximum
Flat & Elongated Ratio, % @ 3:1	ASTM D4791	25 Maximum
% Crushed, single face	ASTM D5821	95 Minimum
% Crushed, Two or more Mechanically crushed faces	ASTM D5821	85 Minimum
Micro-Deval, % loss	AASHTO TP58	18 Maximum

- C. For the Los Angeles abrasion value, the values shown for these tests are targets for aggregate selection purposes. The results of these tests should not be the sole basis for rejection.
- D. Fine aggregate testing shall comply with Table 3.

Table 15 - UTACS Fine Aggregate Specifications

Tests	Method	Limit
Sand Equivalent	AASHTO T176	45 minimum
Methylene Blue (on materials passing 200)	AASHTO TP57	10 maximum
Uncompacted Void Content	AASHTO T304	40 minimum

- E. Values for sand equivalent shown for these tests are targets for aggregate selection purposes. If the finished bituminous mixture passes the AASHTO T283 requirement in the Mix Design section, the sand equivalent and methylene blue requirements may be waived.

SECTION 706**AGGREGATES FOR PORTLAND CEMENT PRODUCTS****SCOPE****706.01.01 MATERIALS COVERED**

- A. This specification covers the quality and size of aggregates used in Portland cement products.

REQUIREMENTS**706.02.01 GENERAL**

- A. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:
1. The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.
 2. The character of the material is such that, in the opinion of the Engineer, undue additional costs may be accrued by the Contracting Agency.
- B. For mix design approval, the proposed proportions of coarse, intermediate, and fine aggregate, combined mathematically by volume or mass, shall produce a mixture within the grading limits for combined aggregates as shown in Table 1 (not applicable to lightweight concrete):

Table 1 - Grading Limits of Combined Aggregates

Sieve Size	Percentage Passing				
	1-1/2-inch Max.	1-inch Max	3/4-inch Max.	1/2-inch Max	3/8-inch Max.
2-inch	100	--	--	-	-
1-1/2-inch	87-100	100	--	-	-
1-inch	65-90	97-100	100	-	-
3/4-inch	48-82	70-100	80-100	100	-
1/2-inch	--	--	--	90-100	100
3/8-inch	39-57	43-70	46-70	70-90	70-100
No. 4	30-45	32-48	34-50	45-60	47-70
No. 8	23-38	23-42	24-42	38-56	34-55
No. 16	15-33	15-34	17-34	24-38	23-43
No. 30	8-24	8-25	10-25	13-27	15-33
No. 50	4-13	4-15	5-15	7-17	7-20
No. 100	1-5	2-7	2-7	0-6	2-8
No. 200	0-5	0-5	0-5	0-5	0-5

- C. If the Contractor prefers a finer gradation for the purpose of slip-form operations, the following gradation is permitted with approval of the Engineer.

Table 2 - Gradation for Slip-Form Operations

Sieve Size	Percentage Passing	
	1-1/2-inch Max.	3/4-inch Max.
2-inch	100	--
1 1/2-inch	87-100	--
1-inch	65-97	100
3/4-inch	48-91	80-100
1/2-inch	--	--
3/8-inch	39-70	46-74
No. 4	30-54	34-54
No. 8	23-38	24-50
No. 16	15-33	17-38
No. 30	8-24	10-29
No. 50	4-13	5-19
No. 100	1-5	2-9
No. 200	0-5	0-5

- D. If the Contractor proposes to use an admixture other than an air-entraining agent, Contractor shall state the complete brand name and the quantity proposed to be used per sack of cement.
- E. Should the Contractor change Contractor's source of supply, Contractor shall submit in writing to the Engineer the new gradation before their intended use.
- F. In addition to the coarse, intermediate, and fine aggregates meeting the individual source requirements, the combined gradation shall meet the following source requirement:

Table 3 - Alkali-Silica Reaction

Source Requirement Test, Combined Aggregates	Test Method	Requirement
Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction	AASHTO T303	0.10% Max. Expansion ¹

- G. Previous AASHTO T303 qualified aggregates for concrete mix designs will not automatically qualify for approval. Submit new AASHTO T303 test results with concrete mix design.
- H. Perform this test on the coarse, intermediate, and fine aggregates together, combined in the same proportions as the proposed mix design.
1. The test may be performed on each size separately and the results combined mathematically.
 2. Perform the test using the proposed sources together with proposed job cement and job pozzolan or other admixture, if used.
 3. The pozzolan and silica fume quantities will be considered as cement in meeting the requirements of cement in Table 2 of Subsection [501.03.04](#), "Classification and Proportions."

¹ This requirement applies to all aggregate used in the concrete bridge structures, including approach slabs, reinforced concrete boxes, walkways, or sidewalks on the bridge structure itself, and all concrete bridge rail.

- I. Prior to mix design approval, the Contracting Agency reserves the right to verify the AASHTO T303 test results, using the sources and proportions of materials as indicated by the mix design.
- J. Conduct another test upon changes in source of cementitious materials, including fly ash, or changes in cement type or mitigating admixture suppliers.

PHYSICAL PROPERTIES AND TESTS

706.03.01 COARSE AGGREGATE

- A. The aggregate shall conform to the following table requirements:

Table 4 - Percentage by Weight Passing Sieve

Sieve Size	Size No. 3 2-inch to 1-inch	Size No. 4 1-1/2-inch to 3/4-inch	Size No. 7 1/2-inch to No. 4	Size No. 57 1-inch to No. 4	Size No. 67 3/4-inch to No. 4	Size No. 357 2-inch to No. 4	Size No. 467 1-1/2-inch to No. 4
2-1/2-inch	100	--	--	--	--	100	--
2-inch	95-100	100	--	--	--	95-100	100
1-1/2-inch	35-70	90-100	--	100	--	--	95-100
1-inch	0-15	20-55	--	95-100	100	35-70	--
3/4-inch	--	0-15	100	--	90-100	--	35-70
1/2-inch	0-5	--	90-100	25-60	--	10-30	--
3/8-inch	--	0-5	40-70	--	20-55	--	10-30
No. 4	--	--	0-15*	0-10*	0-10*	0-5	0-5

*Not more than 5 percent shall pass No. 8 Sieve.

NOTE: Sizes No. 357 and No. 467 shall each be split into 2 sizes. Size No. 357 shall be furnished in stockpile or bunker in Sizes No. 3 (2-inch to 1-inch) and Size No. 57 (1-inch to No. 4.) Size No. 467 shall be furnished in stockpile or bunker in Size No. 4 (1-1/2-inch to 3/4-inch) and Size No. 67 (3/4-inch to No. 4). The two sizes shall be uniformly combined at the mixing plant to comply with the grading requirements of Sizes No. 357 and No. 467 respectively.

Table 5 - Coarse Aggregate Properties

Tests	Test Method	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Material Passing 200 Sieve	AASHTO T27	1% Maximum
Percentage of Wear (100 Rev.)	ASTM C131	10% Maximum
Percentage of Wear (500 Rev.)	ASTM C131	50% Maximum
Soundness (5 Alternations) (sodium sulfate)	AASHTO T104	9% Maximum Loss
Cleanliness Value min.	CALIF 227	71 706.03.01.B.1
Clay Lumps	AASHTO T112	1% Maximum
Potential Reactivity	AASHTO T303	Innocuous 706.03.01.B.2

- B. Thin or elongated pieces (length greater than 5 times maximum thickness) shall not exceed 15 percent by weight.

1. When 2 or more stockpiles are to be combined, each stockpile shall have a cleanness value of at least 65 with a minimum combined cleanness value of 71 calculated by the percent of material used from each stockpile.
 2. If the material from a proposed source fails this test requirement, the material may still be used for concrete aggregate provided that it is incorporated in an approved mix design with an approved Type F or Type N Pozzolan, or with a Type IP cement.
- C. If a pozzolan is used for this purpose, use 1 part pozzolan to 4 parts of cement by mass. The pozzolan quantity shall be considered as cement in meeting the required minimum cement content. If a Type IP cement is used for this purpose, the use of pozzolan is not required.

706.03.02 LIGHTWEIGHT AGGREGATES

- A. These aggregates shall conform to the following requirements:

Table 6 - Lightweight Aggregate Gradation

Sieve Size	Percentage of Weight Passing Sieve			
	Fine Natural	Fine Lightweight	1-inch Size Coarse	3/4-inch Size Coarse
1-inch	--	--	95-100	100
3/4-inch	--	--	--	90-100
1/2-inch	--	--	25-60	--
3/8-inch	100	100	--	20-60
No. 4	95-100	85-100	0-10	0-10
No. 16	45-80	40-80	--	--
No. 50	10-35	10-35	--	--
No. 100	2-12	5-25	--	--
No. 200	0-5	--	--	--

Table 7 - Lightweight Aggregate Properties

Tests	Test Method	Requirements
Sieve Analysis	AASHTO T27	Above 706.03.02.A.1 below
Sampling	ASTM D75	--
Unit Weight (loose oven dry) Fine Aggregate 70 lb/ft ³	Nev. T487	Maximum 706.03.02.A.2 below
Unit Weight (loose oven dry) Coarse Aggregate 55 lb/ft ³		
Unit Weight (loose oven dry) Combined Fine and Coarse Aggregate 65 lb/ft ³		
Organic Impurities	ASTM C40	Satisfactory 706.03.02.A.3 below
Clay Lumps	AASHTO T112	2.0% Maximum
Test for Staining Materials	ASTM D330	Satisfactory 706.03.02.A.4 below
Mortar Making Properties of Sand	ASTM C87	95% Minimum 706.03.02.A.5 below

1. With the following exceptions: The weight of the test sample for the fine lightweight aggregate shall be in accordance with Table 8, and the aggregate when mechanically

sieved shall be sieved for only 5 minutes. The test sample for coarse aggregate shall consist of no less than 0.1 cubic foot of the material used for the determination of unit weight.

Table 8 - Weight of Sieve Test Sample for Fine Lightweight Aggregates

Nominal Weight of Aggregate		Weight of Test Sample	
(lbs/ft ³)	kg/m ³	Grams	Oz.
25-35	401-561	150	5.3
35-45	561-721	200	7.0
45-55	721-881	250	8.8
55-65	881-1042	300	10.6
65-70	1042-1122	350	12.3

- The unit weight of successive shipments of lightweight aggregate shall not differ by more than 10 percent from that of the sample submitted for acceptance tests.
- Aggregates tested and showing color darker than the standard shall be rejected unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.
- Aggregates tested and showing stain darker than "heavy stain" (stain index of 80) shall be tested by chemical procedure, and aggregates that contain 1.5 mg or more of ferric oxide (Fe₂O₃) per 200 gram sample shall be rejected for use.
- Fine Aggregate failing in the test for organic impurities (ASTM C40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with ASTM C87 is not less than 95 percent.

706.03.03 FINE AGGREGATE

- A. This aggregate shall conform to the following requirements:

Table 9 - Fine Aggregate Gradation

Sieve Sizes	Percentage by Weight Passing Sieve
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-35
No. 100	2-12
No. 200	0-5

Table 10 - Fine Aggregate Properties

Tests	Test Method	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Soundness (5 alternations) (sodium sulfate)	AASHTO T104	10% Maximum Loss
Clay Lumps	AASHTO T112	1.0% Maximum
Lightweight Pieces in Aggregate (less than 2.0 sp. gr.)	AASHTO T113	1.0% Maximum

Table 10 - Fine Aggregate Properties

Tests	Test Method	Requirements
Organic Impurities	ASTM C40	Satisfactory 706.03.03.A.2 below
Mortar Making Properties	ASTM C87	95% Minimum 706.03.03.A.1 below

1. Aggregates tested and showing color darker than the standard shall be rejected unless they pass the mortar making properties test in accordance with ASTM C87.
2. Fine aggregate failing in the test for organic impurities (ASTM C40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength of 7 and 28 days calculated in accordance with ASTM C87 is not less than 95 percent.
3. If the material from a proposed source fails this test requirement, the material may still be used for concrete aggregate provided that it is incorporated in an approved mix design with an approved Type F or Type N Pozzolan, or with a Type IP cement.
 - a. If a pozzolan is used for this purpose, use 1 part pozzolan to 4 parts of cement by mass.
 - b. The pozzolan quantity shall be considered as cement in meeting the required minimum cement content.
 - c. The limitation on replacement of cement with pozzolans at a minimum of 20 percent in Subsection [501.02.03](#), "Admixtures," is hereby waived to meet this requirement.
 - d. If a Type IP cement is used for this purpose, the use of pozzolan is not required.

706.03.04 GROUT AND MORTAR SAND

- A. This aggregate shall conform to the following requirements:
- B. Sand for grout and mortar shall conform to the size requirements of Subsection [706.03.03](#), "Fine Aggregate," except if the Contractor elects, Contractor may screen the sand over a No. 8 screen to produce the following:

Table 11 - Grout Aggregate Gradation

Sieve Sizes	Percentage by Weight Passing Sieve
No. 8	100
No. 50	15-40
No. 100	0-10
No. 200	0-5

Table 12 - Grout Aggregate Properties

Tests	Test Method	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	-----
Organic Impurities	ASTM C40	Satisfactory 706.03.04.B.2
Mortar Making Properties	ASTM C87	95% Minimum 706.03.04.B.1

1. Aggregates tested and showing color darker than the standard shall be rejected unless they pass the mortar making properties test in accordance with ASTM C87.

2. Fine aggregate failing in the test for organic impurities (ASTM C40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with ASTM C87 is not less than 95 percent.

706.03.05 RIPRAP GROUT

- A. The mix design for the placing requirements addresses 2 placement methods:
 1. Direct discharge from the transit mixer.
 2. Placement by small diameter line pumping methods.
- B. Two typical mixtures that would meet the above minimum requirements are as follows:

Table 13 - Proportions for 1.0 Cubic Yard of Grout

	Pump Method Approx. Volume (Cu. Ft.)	Transit Mixer Discharge Approx. Volume (Cu. Ft.)
Pea Gravel	3.5	7.6
Washed Concrete Sand	10.6	7.6
Water	6.5	5.9
Type V cement	3.5	3.1
Fly Ash class F	1.6	1.4
Balance Air	1.3	1.4

- C. Factors which shall be considered for a given grout mix are:
 1. Fine and coarse aggregates.
 2. Consistency.
 3. Elapse time between placement and initial set.
 4. Length of time between batching and placement during which continuous or intermittent mixing is required.
- D. Materials used in the production of riprap grout shall meet the minimum following material standards:
 1. Fine and Coarse Aggregate: ASTM C33; Section [206](#), "Structure Excavation."
 2. Portland Cement: ASTM C150, Type V; Section [701](#), "Hydraulic Cement."
 3. Fly Ash: ASTM C618; Section [729](#), "Fly Ash."
 4. Water: Section [722](#), "Water."
 5. Air Entraining Admixture: ASTM C260; Section [702](#), "Aggregates for Portland Cement Products."
- E. A trial batch shall be placed for review by the Engineer for final approval for the project.
- F. The Engineer shall be provided with a legible ticket with each load of grout delivered to the project site which shall contain the following information:
 1. Name of Vendor.
 2. Name of Contractor.

3. Number of Cubic Yards in the Load.
4. Actual Weights of Cement and of each Size of Aggregate.
5. Amount of Water Added at the Plant.
6. Amount of Water in the Aggregate.
7. Brand and Type of Cement.
8. Brand and Amount of Admixture.
9. Time and Date of Batching.

SECTION 707

JOINT MATERIAL

SCOPE

707.01.01 MATERIAL COVERED

- A. This specification covers the quality requirements for poured filler, preformed fillers, and resilient and rubber type gaskets used in the construction of bridges, culverts, sidewalks, and so forth.

REQUIREMENTS

707.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

707.03.01 JOINTS

- A. Materials for joints in concrete structures shall comply with provisions specified below.

707.03.02 POURABLE JOINT SEALER

- A. The materials specified in this subsection shall be supplied and installed in weakened plane joints, contraction joints, and construction joints when required by the Engineer and as shown on the drawings.
- B. Joint Sealant:
1. 2-component polyurethane pourable joint sealant (ACI 504R, Table 1, Type IV).
 2. Sealant shall be able to expand and compress plus or minus 25 percent movement as the joint opens and closes.
 3. Sealant shall be self-leveling for flat surfaces and non-sagging for sloped and vertical joints.
 4. Sealant shall meet or exceed requirements of Table 1 below.

Table 1 - Minimum Requirements for Pourable Joint Sealer

Material Characteristics	Self-Leveling	Non-Sagging
Application Temperature	40 to 100 degrees F	40 to 100 degrees F
Service Range	-40 to 170 degrees F	-40 to 170 degrees F
Curing Rate	Tack-free Time: 1-2 hours Final Cure: 3-5 days	Tack-free Time: 6-8 hours Final Cure: 3 days
Tear Strength (ASTM D624)	--	45 lbs/in
Shore A Hardness (ASTM D2240)	45 ±5 (21-day)	25 ±5
Tensile Properties (ASTM D412):		
Tensile Strength	550 psi (21-day)	120 psi (at break)
Elongation	700% (at break)	500%
Modulus of Elasticity (100%)	150 psi	70 psi
Adhesion in Peel, Concrete Substrate (Fed Spec TT-00227E):		
Peel Strength	>30 pounds	25 pounds
% Adhesion Loss	0%	0%

- C. No material shall be used that has skinned over or settled in the container to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.
- D. Each container shall be clearly labeled or each delivery of material in the tanks of 2-component equipment shall be accompanied with a ticket showing designation (Component A or B), the manufacturer's name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer's instructions for use.
- E. The sealant shall be machine mixed and placed with equipment that accurately proportions and mixes the 2 components and extrudes the mixed material into the joint.
 - 1. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed.
 - 2. Polyurethane liquid components that have been exposed to the atmosphere for more than 24 hours shall not be used.
- F. Primer:
 - 1. Special material furnished by the manufacturer of the sealant to improve bond of polyurethane sealant to concrete.
 - 2. Primer shall be applied to the sides of the groove and to all exposed vertical surfaces in the joint prior to placing the polyurethane sealant.
 - 3. The primer shall be dry prior to placing the sealant.
 - 4. Contaminated primer shall be removed and replaced.

707.03.03 CHANNEL EXPANSION JOINT (1-INCH OR LESS)

- A. The materials specified in this subsection shall be supplied and installed in expansion joints with widths 1-inch or less designed for channels included in Clark County Regional Flood Control District's Master Plan.
- B. Joint Sealant:
 - 1. 2-component polyurethane pourable joint sealant (ACI 504R, Table 1, Type IV).
 - 2. Sealant shall be able to withstand up to plus or minus 25 percent movement.
 - 3. Sealant shall be self-leveling for flat surfaces and non-sagging for slopes.
 - 4. The sealant shall meet or exceed requirements of Table 1 in Subsection [707.03.02](#), "Pourable Joint Sealer."
- C. No material shall be used that has skinned over or settled in the container to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.
- D. Each container shall be clearly labeled or each delivery of material in the tanks of 2-component equipment shall be accompanied with a ticket showing designation (Component A or B), the manufacturer's name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer's instructions for use.
- E. The sealant shall be machine mixed and placed with equipment that accurately proportions and mixes the 2 components and extrudes the mixed material into the joint.
 - 1. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed.

2. Polyurethane liquid components that have been exposed to the atmosphere for more than 24 hours shall not be used.
- F. Joint Filler: Preformed, ASTM D1752, Type I (sponge rubber) or inert, preformed, closed cell, polypropylene material.
- G. Bond Breaker Tape:
1. Adhesive backed polyethylene tape meeting or exceeding the following:
 - a. Adhesive Strength: 35 ounces/inch width.
 - b. Tensile Strength: 20 pounds./inch width.
 - c. Mil thickness: 14.
 2. Size tape so that it covers the entire back surface of the joint without extending up the concrete slabs.
 3. In joints that have considerable width variation, 1 tape may be lapped over another to accomplish total backside coverage.
 4. Bond breaker tape shall be thick enough to permit easy handling and proper insertion.
- H. Backer Rod:
1. Non-absorbent expanded, closed cell polyethylene foam.
 2. The backer rod shall be approximately 25 percent larger in diameter than the width of the joint to be sealed.
 3. Other back-up materials (paper, rope and open cell foam) are unacceptable.
 4. The backer rod shall be compatible with the sealant, and no bond or reaction shall occur between the backer rod and sealant.

707.03.04 EXPANSION JOINT (1-INCH OR LESS)

- A. The materials specified in this subsection shall be supplied and installed in expansion joints with widths 1-inch or less designed for structures other than those listed in Subsection [707.03.03](#), "Channel Expansion Joint (1-Inch or Less) Filler."
- B. Joint Sealant:
1. 2-component polyurethane pourable joint sealant (ACI 504R, Table 1, Type IV).
 2. Sealant shall be able to withstand up to plus or minus 25 percent movement.
 3. Sealant shall be self-leveling for flat surfaces and non-sagging for slopes.
 4. The sealant shall meet or exceed requirements of Table 1 above.
- C. No material shall be used that has skinned over or settled in the container to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.
- D. Each container shall be clearly labeled or each delivery of material in the tanks of 2-component equipment shall be accompanied with a ticket showing designation (Component A or B), the manufacturer's name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer's instructions for use

- E. The sealant shall be machine mixed and placed with equipment that accurately proportions and mixes the 2 components and extrudes the mixed material into the joint.
 - 1. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed.
 - 2. Polyurethane liquid components that have been exposed to the atmosphere for more than 24 hours shall not be used.
- F. Joint Filler:
 - 1. Preformed filler conforming to AASHTO M213 or ASTM D1751 (fiber type).
 - 2. Filler material shall be punched or drilled to admit dowels where called for on the plans.
 - 3. Filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise specified by the Engineer.
 - 4. When the use of more than 1 piece is authorized for a joint, the abutting ends shall be fastened securely and held in place, by stapling or other positive fastening satisfactory to the Engineer.
- G. Bond Breaker Tape:
 - 1. Adhesive backed polyethylene tape meeting or exceeding the following:
 - a. Adhesive Strength: 35 ounces/inch width.
 - b. Tensile Strength: 20 pounds./inch width.
 - c. Mil thickness: 14.
 - 2. Size tape so that it covers the entire back surface of the joint without extending up the concrete slabs.
 - 3. In joints that have considerable width variation, 1 tape may be lapped over another to accomplish total backside coverage
 - 4. Bond breaker tape shall be thick enough to permit easy handling and proper insertion.
- H. Backer rod:
 - 1. Non-absorbent expanded, closed cell polyethylene foam.
 - 2. The backer rod shall be approximately 25 percent larger in diameter than the width of the joint to be sealed.
 - 3. Other backer materials (paper, rope and open cell foam) are unacceptable.
 - 4. The backer rod shall be compatible with the sealant and no bond or reaction shall occur between the backer rod and sealant.

707.03.05 EXPANSION JOINT (GREATER THAN 1-INCH)

- A. The materials specified in this subsection shall be supplied and installed in expansion joints with widths greater than 1-inch.
- B. Joint Sealant:
 - 1. Impermeable closed-cell, cross-linked, ethylene vinyl acetate, low density polyethylene copolymer, nitrogen blown foam material.

2. Joint sealant shall have a minimum working movement range of 60 percent compression and 30 percent tension.
 3. The sealant shall meet or exceed the requirements listed in Table 2 below.
 4. Joint sealant shall have 1/8-inch" deep by 1/8-inch wide grooves spaced at 1/4 inch to 1/2 inch along both sides of the joint and running the entire length of the joint to increase bond surface area.
 5. Joint sealant material shall be resistant to degradation due to ultraviolet radiation or shall be coated with a material that provides adequate protection.
 6. The joint sealant shall be installed with a width 25 percent greater than width of joint opening at a near neutral condition.
 7. All direction changes in joint sealant shall be done using heat welding method.
 8. Joint sealant shall be installed using all of manufacturer's recommendations.
 9. Joint sealant shall be installed prior to significant joint movement after concrete placement.
- C. Contractor shall prevent construction equipment from traversing joint after sealant has been placed or adequate steps shall be taken to protect sealant from construction traffic.

Table 2 - Minimum Requirements for Preformed Joint Sealer

Material Characteristics	Physical Requirements
Service Range	-94 degrees F to 160 degrees F
Tensile Strength	115 lb/in ²
Elongation at break	255%
Tear Resistance (ASTM D624)	16 lb/in ²
Water Absorption (ASTM D3575, Suffix L)	0.2 lb/ft ²
Density	2.8–3.4 lb/ft ³

- D. Joint Filler: Inert, preformed, closed cell, polypropylene material.
- E. Bond Breaker Tape:
1. Adhesive backed polyethylene tape meeting or exceeding the following:
 - a. Adhesive Strength: 35 ounces/inch width.
 - b. Tensile Strength: 20 pounds./inch width.
 - c. Mil thickness: 14.
 2. Size tape so that it covers the entire back surface of the joint without extending up the concrete slabs.
 3. In joints that have considerable width variation, 1 tape may be lapped over another to accomplish total backside coverage.
 4. Bond breaker tape shall be thick enough to permit easy handling and proper insertion.
- F. Bonder: 2-component, 100 percent solid epoxy adhesive designed to bond joint material to steel, cured concrete, or wood.

707.03.06 RUBBER GASKETS

A. The ring gaskets shall conform to AASHTO M198.

707.03.07 WATERSTOPS

A. Waterstops shall conform to the following requirements:

1. Natural rubber waterstops shall be manufactured from a stock composed of a high grade compound made exclusively from new plantation rubber, reinforced carbon black, zinc oxide, accelerators, antioxidants, and softeners.
2. This compound shall contain not less than 72 percent by volume of new plantation rubber.

NATURAL RUBBER.

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength: 3,500 psi minimum Elongation at breaking: 550 percent Unit stress (300 percent): 1,100 psi minimum Unit stress (500 percent): 2,800 psi minimum
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158 degrees F (± 2 degrees F) or after 48 hours in oxygen at 158 degrees F (± 2 degrees F) and 300 psi, the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber by Means of a Durometer	ASTM D2240	55 to 65 hardness

SYNTHETIC RUBBER

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 2,500 psi minimum Elongation at breaking of 425 percent.
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158 degrees F (± 2 degrees F) or after 48 hours in oxygen at 158 degrees F (± 1 degree F) and 300 psi, the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber By Means of a Durometer	ASTM D2240	50 to 70 hardness

POLYVINYL CHLORIDE

Test	Test Method	Requirements
Polyvinyl Chloride Waterstops	Corps of Engr CRD-C 572	Compliance with paragraph 6

707.03.08 ASPHALT PLANK

A. Asphalt plank shall conform to ASTM D517 for Plain Asphalt Plank.

707.03.09 PREFORMED ELASTIC JOINT SEALER

A. Preformed elastic joint sealer and lubricant adhesive shall conform to AASHTO M220.

- B. The lubricant adhesive shall be homogeneous and shall remain workable from 5 degrees F to 120 degrees F.
1. Each lot of the adhesive shall be in containers with the manufacturer's name or trademark and the date of manufacture plainly marked.
 2. Adhesive shall be stored at a temperature of 50 degrees F to 80 degrees F and shall be used within 270 days after the date of its manufacture.
- C. The lubricant adhesive shall conform to the following requirements:
1. Average new weight per gallon, pounds: 7.84 \pm 5%.
 2. Solids content by weight, percent: 22 - 28.
- D. Each lot of the preformed elastic joint sealer and lubricant adhesive furnished under these specifications shall be identified as specified herein and shall be products that have been tested by a reputable testing laboratory, recognized by the Contracting Agency.
1. The testing laboratory shall certify that the materials meet these specifications and requirements.
 2. The Contractor shall furnish the Contracting Agency with these certifications prior to using the material.

707.03.10 SUBMITTAL

- A. Material shall be tested and certified in accordance with the Table 3 frequencies.
1. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and requirements.
 2. The test shall be performed in an accredited laboratory such as the American Association for Laboratory Accreditation (A2LA) or other as approved by the Engineer.
 3. A test certificate shall be included with the certifying document.
 4. Subsequent submittals shall be reviewed by the Contractor for compliance then transmitted to the Engineer.
- B. The Statute of Limitations duration for the record storage shall be as required by the Nevada Revised Statutes.

Table 3 - Quality Control Inspection and Testing

Product	Subsection	Reference	Submittal	Frequency
Joint Sealant	707.03.02	Table 1 requirements	Certification with copy of tests	1 per lot
	707.03.03			
	707.03.04	ACI 504R, Table 1, Type IV		
Joint Filler	707.03.05	Table 2 requirements		
	707.03.03	Tested per ASTM D1752 Type I	Certification with copy of tests	1 per lot
	707.03.04	AASHTO M213		
Backer Rod	707.03.05	Inert, preformed, closed cell, polypropylene material	Certification	1 per lot
	707.03.03	Non-absorbent expanded, closed cell polyethylene	Certification	1 per lot
	707.03.04			

Bond Breaker	707.03.03	Adhesive strength 35 ounces/in width	Certification with copy of tests	1 per lot
Tape	707.03.04	Tensile Strength 20 lb/in width		
	707.03.05	Thickness 14 mil minimum		
Rubber Gaskets	707.03.06	AASTHO M198		
Waterstops Natural and Rubber	707.03.07	ASTM D412 ASTM D572 ASTM D2240		
Waterstops Polyvinyl Chloride	707.03.07	Corps of Engr CRD-C 572		
Asphalt Plank	707.03.08	ASTM D517		
Preformed Elastic Joint Sealer	707.03.09	AASHTO M220		

SECTION 708

CONCRETE AND CLAY PIPE AND DRAINS

SCOPE

708.01.01 MATERIALS COVERED

- A. This specification covers the quality of clay pipe, nonreinforced concrete pipe, and reinforced concrete pipe used for culverts, siphons, pressure conduits, and storm drains and also the quality of perforated pipe used in underdrains.
 - 1. The quality of pipe used for sanitary sewers shall be as specified in Section [630](#), "Sanitary Sewers."
 - 2. Quality control testing and inspection requirements are in Subsection [708.04.01](#), "Production Quality Control Inspection and Testing."
- B. Concrete pipe that is precast shall be manufactured in an annually certified plant.
 - 1. Certification shall be by the American Concrete Pipe Association (ACPA).
 - 2. The quality program from the certification process and this specification shall be initially submitted to the Regional Transportation Commission Specification Subcommittee for approval.
 - 3. Once approved, the facility is considered "Authorized" and submittals of the QC program will not be required on a per-project basis unless required in the project specifications.
- C. Design in accordance with AASHTO LRFD Bridge Design Specifications, Section 12, and to withstand a backfill dead load of 120 pounds per cubic foot and an HS-20 live load, unless otherwise shown in the contract or approved by the Engineer. The minimum cover over a pipe shall be placed on the plans and/or specifications being submitted for plan review.
- D. The design shall consider any flotation effects with the use of controlled low strength material for backfill.
- E. For storm drain application, the design shall consider the abrasion effects of parameters outlined in the Clark County Regional Flood Control District design manual or Federal Highway Administration (FHWA) publication FHWA-DF-88-003, "Federal Lands Highway Project Development and Design Manual."
- F. The trench section installation configuration as demonstrated in Figure 1 in Section [208](#), "Trench Excavation and Backfill," shall only be permitted when approved by the Engineer.
- G. The designing engineer shall comply with the intent of the pipe material as defined as either rigid or flexible in conformance with the AASHTO LRFD Bridge Design and Construction Specifications and this section.
 - 1. Special attention shall be given to the sidewall material properties as this section assumes a minimum AASHTO A1 or A3 material.
 - 2. Other sidewall material type shall be given special consideration for minimum trench widths, the use of CLSM, or other critical processes that would affect the pipe ability to withstand the load and shall also be noted on the plans and specifications for the project.

- H. The type of pipe and applicable installation requirement (trench and embankment) to be used as demonstrated by the design and approved by the Engineer shall be clearly noted on the drawings and specifications along with installation procedures that may differ from this section.
- I. The design shall include definition of either rigid or flexible pipe as defined by the South African Standard SABS 0102 as outlined on the Clark County QAQC web page:
www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx
- J. The minimum design life before first maintenance on all pipes shall be 50 years. The definition of first maintenance is as follows:
1. **Rigid Pipe or Box - Reinforced Concrete:** Point of exposed reinforcement from normal designed use
 2. **Rigid Pipe – Nonreinforced:** The least value of the thickness from designed use by a reduction of 25 percent or 1 inch.
- K. Joints shall be specified in accordance with the following:

Table 1- Joint Types				
Pipe Type	Joint Type	Description	Test Pressure	Application
Non-pressure	Silt Tight	Mastic or Rubber Gasketed	2.0 psi	Storm
Pressure	Water Tight (pressure)	Rubber Gasketed	10.8 psi	Storm

708.01.02 BASIS OF MANUFACTURED LOT ACCEPTANCE

- A. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on manufacture's tests and inspection as indicated in Subsection [708.04.01](#), "Production Quality Control Inspection and Testing," Table 1.
- B. The Contractor shall submit to Engineer manufacturer's Certificate of Compliance for each type of pipe furnished, in accordance with the provisions of Subsection [106.05](#), "Certificates of Compliance," and these specifications.
1. The certificate shall certify that the pipe complies with the specifications and shall include the pipe classification, diameter, and the date of manufacture.
 2. The batch test results of each material lot delivered to the project shall be attached to the certificate.

REQUIREMENTS

708.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

708.03.01 REINFORCED CONCRETE PIPE

- A. Reinforced concrete pipe shall conform to the following requirements:
1. **Circular Pipe:** ASTM C76, ASTM C1417.
 2. **Elliptical Pipe:** ASTM C507.
- B. The above ASTM specifications are clarified and amended as follows:

1. Reinforced Concrete Pipe (RCP) ASTM C76, Basis of Manufactured Lot Acceptance. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on the authorized status of the facility and visual defects or imperfections as delivered to the site.
2. Reinforced Concrete Arch Pipe (RCAP) ASTM C507, Reinforced Concrete Elliptical Pipe (RCEP) Basis of Manufactured Lot Acceptance. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on the authorized status of the facility and visual defects or imperfections as delivered to the site.

C. Materials:

1. Cement and Fly Ash:

- a. Unless otherwise specified, cement shall be Type V, Type IP, or Type V and fly ash, and shall conform to Section [701](#), "Hydraulic Cement."
- b. Fly ash shall be Class F and conform to Section [729](#), "Fly Ash."

2. Concrete: Unless otherwise specified, Portland cement concrete shall be as specified in Section [501](#), "Portland Cement Concrete."

3. Synthetic Fibers:

- a. Polypropylene fibers may be used, with the approval of the Engineer, as a nonstructural manufacturing material.
- b. Only Type III synthetic fibers designed and manufactured specifically for use in concrete and conforming to ASTM C1116 shall be accepted.

4. Admixtures: Unless otherwise specified or approved by the Engineer, admixtures conforming to Section [702](#), "Concrete Curing Materials and Admixtures," shall be acceptable for use.

D. All D-load and/or compressive strength requirements shall be met prior to shipment.

708.03.02 NONREINFORCED CONCRETE PIPE

- A. This pipe shall conform to ASTM C14 for the specified diameters and strength classes.

708.03.03 PERFORATED CONCRETE PIPE

- A. This pipe shall conform to ASTM C444 for the specified diameters and strength classes.

708.03.04 CLAY PIPE

- A. This pipe shall conform to AASHTO M65 for pipe with full circular cross section, for the specified diameter and strength class.
- B. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self-centering feature.

708.03.05 BLANK

708.03.06 BLANK

708.03.07 BLANK

708.03.08 BLANK

708.03.09 REINFORCED CONCRETE PRESSURE PIPE

- A. This pipe shall conform to AWWA C300, AWWA C301, AWWA C302, and ASTM C361.

TESTING AND INSPECTION**708.04.01 PRODUCTION QUALITY CONTROL INSPECTION AND TESTING**

- A. Material shall be tested, inspected, and certified in compliance with the Table 2 frequency.
- B. The laboratory shall be R-18 AASHTO accredited in the appropriate test method, where applicable, and testing reviewed and stamped by a Nevada professional engineer who has responsible charge of the work.
1. Any structural integrity test shall be reviewed and stamped by a Nevada professional engineer who has responsible charge of the work.
 2. Chemical testing does not require a professional engineer's review and stamp.
- C. Review the Clark County web site for any exceptions to the test methods listed below at <http://www.accessclarkcounty.com/pubworks/iqac/QA.htm>.

Table 2 – Inspection and Testing				
Product/Material	Subsection	Referenced Specification or Test Procedure	Requirement	Frequency
Concrete Pipe				
Plant QC Program	708.01.01	ACPA	Certified annually	1 per new plant or revision
Reinforced Concrete Pipe	708.03.01	ASTM C76, ASTM C1417	Design submittal	1 per type
		ASTM C76, Section 5.1.2	Basis of manufactured lot acceptance	See Components below
Reinforced Concrete Elliptical Pipe	708.03.01	ASTM C507, Section 5.1.1 and ASTM C655, Section 9	Design submittal	1 per type
		ASTM C76, Section 5.1.2	Basis of manufactured lot acceptance	See Components below
Nonreinforced Concrete Pipe	708.03.02	AASHTO M315 and ASTM C14	Design submittal	1 per type
		ASTM C14	Basis of manufactured lot acceptance	See Components below
Perforated Concrete Pipe	708.03.03	ASTM C444	Design submittal	1 per type
			Basis of manufactured lot acceptance	See Components below
Reinforced Concrete Pressure Pipe (Water)	708.03.09	AWWA C300, AWWA C301, and AWWA C302	Design submittal	1 per type
			Basis of manufactured lot acceptance	See Components below

Table 2 – Inspection and Testing				
Product/Material	Subsection	Referenced Specification or Test Procedure	Requirement	Frequency
Components				
Cement	708.03.01	Section 701	Certificate with test of Batch lot	1 per batch or heat lot
Curing Compound and Admixtures	708.03.01	Section 702		
Fly Ash	708.03.01	Section 729		
Steel Wire Steel Welded Wire Steel Wire Welded Deformed Steel Wire Welded Wire Deformed		Section 713		
Aggregates Coarse and Fine		AASHTO M6 and AASHTO M80	Sieve Analysis	1 per day for QA of External Source
Concrete		Section 501	Design submittal	1 per new design and renewal each year
		AASHTO T22	Compressive Strength	1 set per production day per design
Pipe	708.03.01	ASTM C655	D-Load testing	Annually per size and class
	708.03.01	Applicable AWWA and ASTM methods	Inspection of diameter, wall thickness, steel area, product marking (size and length), length	Each piece
Pressure Pipe Joint	708.01.01	ASTM C497 and ASTM C443	Hydrostatic Test	1 per setup or change

SECTION 709**METAL AND THERMOPLASTIC PIPE****SCOPE****709.01.01 MATERIAL COVERED**

- A. This specification covers the quality of metal pipes, metal arch pipes, metal end sections, structural plate pipe, perforated metal pipe, and thermoplastic pipe used for culverts, drainage structures, conduits, underdrains, and storm sewer.
- B. The quality of pipe for the sanitary sewer shall be in accordance with Section [630](#), "Sanitary Sewers," or Responsible Agency specifications.
- C. Plastic pipe shall be manufactured in an annually certified plant.
 - 1. Certification shall be by the Plastic Pipe Institute (PPI) or other Contracting Agency approved program.
 - 2. The quality program from the certification process and this specification shall be initially submitted to the Regional Transportation Commission Specification Subcommittee for approval.
 - 3. Once approved, the facility is considered "Authorized" and submittals of the QC program will not be required on a per-project basis unless required in the project specifications.
- D. The metal pipe manufacturer shall be authorized and be annually certified by a procedure approved by the Regional Transportation Commission Specification Subcommittee.
 - 1. The Quality Program used for the certification and this specification shall be submitted prior to construction activities.
 - 2. Once approved, the facility is considered "Authorized" and submittals of the QC program will not be required on a per-project basis unless required in the project specifications.
 - 3. All pipes shall be clearly marked with certification program identification.
- E. Design in accordance with AASHTO LRFD Bridge Design Specifications, Section 12, and to withstand a backfill dead load of 120 pounds per cubic foot and an HS-20 live load, unless otherwise shown in the contract or approved by the Engineer. The minimum cover over a pipe shall be placed on the plans and/or specifications being submitted for plan review.
- F. The design shall consider any flotation effects with the use of controlled low strength material for backfill.
- G. For storm drain application, the design shall consider the abrasion effects of parameters outlined in the Clark County Regional Flood Control District design manual or Federal Highway Administration (FHWA) publication FHWA-DF-88-003, Federal Lands Highway Project Development and Design Manual.
- H. The trench section installation configuration as demonstrated in Figure 1 in Section [208](#), "Trench Excavation and Backfill," shall only be permitted when approved by the Engineer.

- I. The designing engineer shall comply with the intent of the pipe material as defined as either rigid or flexible in conformance with the AASHTO LRFD Bridge Design and Construction Specifications and this section.
 - 1. Special attention shall be given to the sidewall material properties as this section assumes a minimum AASHTO A1 or A3 material.
 - 2. Other sidewall material type shall be given special consideration for minimum trench widths, the use of CLSM, or other critical processes that would affect the pipe ability to withstand the load and shall also be noted on the plans and specifications for the project.
- J. The type of pipe and applicable installation requirement (trench and embankment) to be used as demonstrated by the design and approved by the Engineer shall be clearly noted on the drawings and specifications along with installation procedures that may differ from this section.
- K. The design shall include definition of either rigid or flexible pipe as defined by the South African Standard SABS 0102 as outlined on the Clark County QAQC web page:
www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx
- L. The minimum design life before first maintenance on all pipes shall be 50 years. The definition of first maintenance is as follows:
 - 1. **Flexible Pipe:** Point of first perforation from designed use.
- M. Joints shall be specified in accordance with the following:

Table 1 - Joint Types				
Pipe Type	Joint Type	Description	Test Pressure	Application
Non-pressure	Silt Tight	Rubber Gasketed	2.0 psi	Storm
Pressure	Water Tight (pressure)	Rubber Gasketed	10.8 psi	Storm

The amount of corrugation coverage for the joint shall be fully engaged in accordance with the banding requirements for the pipe being testing.

REQUIREMENTS

709.02.01 BASIS OF MANUFACTURED LOT ACCEPTANCE

- A. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on manufacturer's tests and inspection as indicated in Subsection [709.04.01](#), "Production Quality Control Inspection and Testing," Table 4 through Table 7.
- B. The Contractor shall submit to Engineer the manufacturer's Certificate of Compliance for each type of pipe furnished, in accordance with Subsection [106.05](#), "Certificate of Compliance," and these specifications.
 - 1. The certificate shall certify that the pipe complies with the specifications, and shall include the pipe classification, diameter, and the date of manufacture.
 - 2. The batch test results of each material lot delivered to the project shall be attached to the certificate.

PHYSICAL PROPERTIES AND TESTS

709.03.01 CORRUGATED METAL PIPE AND PIPE ARCHES

- A. These conduits and the coupling bands shall conform to AASHTO M36 for the specified sectional dimensions and coating.
- B. Special sections, such as elbows, tees, and wyes for these conduits shall be of the same gauge as the conduit to which they are joined, and shall conform to AASHTO M36.
- C. When metal end sections are required, the following requirements shall pertain:
 - 1. Metal end sections shall be of the gauge shown on the plans.
 - 2. The end of the pipe shall be furnished with annular corrugations to conform to metal end sections so that no leakage results from the connection; however, other designs may be used if approved by the Engineer.
 - 3. Where connector sections are used, the connector section shall be helical or annular as required to match the type of pipe used.
- D. Gauges of conduits shall conform to the requirements shown on the plans.
- E. Connecting bands may be 2 gauges lighter than that used for pipe but not more than 12 gauge or less than 18 gauge. Unless otherwise approved by the Engineer, 2-piece bands shall be required for pipe greater than 48 inches in diameter.
- F. Pipe thickness and coating shall be designed to withstand native soil corrosivity factors including, but not limited to, pH and electrical resistivity of the soil, for a minimum life of 50 years to first perforation.
- G. The electrical resistivity of the soil shall be determined by California Test Method 643, "Method for Estimating the Service Life of Steel Culverts."
 - 1. Test Method 643 will also be used to determine the anticipated service life for galvanized pipe.
 - 2. For pipe coatings other than galvanized, the estimated service life shall be determined by applying appropriate correction factors to the value determined by California Test Method 643, or as indicated in the following sections.

709.03.02 BITUMINOUS COATED CORRUGATED METAL PIPE AND PIPE ARCHES

- A. These conduits and the coupling bands shall conform to AASHTO M36 for the specified sectional dimensions and gauges, and to AASHTO M190 for the type of bituminous coating.
 - 1. Coupling bands shall be fully coated with bituminous material.
 - 2. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.
- B. Special sections, such as elbows and flared end sections, for these conduits shall be of the same gauge as the conduit to which they are joined, and shall conform to AASHTO M190. Coating and invert paving shall be of the type specified.

709.03.03 ALUMINIZED TYPE II COATED CORRUGATED STEEL PIPE

- A. This pipe shall conform to AASHTO M36 and more specifically to the metallic coating specification AASHTO M274.

- B. In addition, the use of aluminized Type II coated corrugated steel pipe shall be limited by the following conditions:
1. Minimum Resistivity $R > 1500$ for $5 < \text{pH} < 9$
 2. Minimum Resistivity $R > 1000$ for $6.1 < \text{pH} < 8.2$

709.03.04 CORRUGATED ALUMINUM PIPE

- A. This pipe shall conform to AASHTO M196.
- B. In addition, the use of corrugated aluminum pipe shall be limited by the following condition in accordance with FHWA-DF-88-003, Federal Lands Highway Project Development and Design Manual:
1. Minimum Resistivity $R > 500$ ohm-cm and $4 < \text{pH} < 9$

709.03.05 POLYMER COATED CORRUGATED STEEL PIPE

- A. This pipe shall conform to AASHTO M36 and more specifically to the coating specification AASHTO M245.
- B. In addition, the use of polymer coated corrugated steel pipe shall be limited by the following condition:
1. Minimum: Resistivity $R > 250$ ohm-cm and $3 < \text{pH} < 12$

709.03.06 CONCRETE LINED CORRUGATED STEEL PIPE

- A. This pipe shall conform to Subsection [709.03.03](#), "Aluminized Type II Coated Corrugated Steel Pipe," for pipe and to ASTM A849 except as modified by the following concrete lining specifications:
1. **Composition.** Concrete for the lining shall be composed of cement, fine aggregate, and water that are well mixed and of the consistency to produce a dense, homogeneous, non-segregated lining.
 2. **Mixture.**
 - a. The aggregates shall be sized, graded, proportioned, and thoroughly mixed with proportions of cement and water to produce a homogeneous concrete mixture of such quality that the pipe will conform to this specification.
 - b. In no case, however, shall the concrete mixture be less than a 6-sack mix in accordance with Section [701](#), "Hydraulic Cement."
- B. The lining shall have a minimum thickness of 1/8 inch above the crest of the corrugations.
- C. The lining shall be applied:
1. To produce a homogeneous non-segregated lining throughout.
 2. In a 2-course application.
- D. The lining shall be mechanically trowelled.

709.03.07 CORRUGATED METAL PIPES FOR DOWNDRAINS

- A. Downdrain flumes and pipe shall conform AASHTO M36.
- B. Type III inlets shall conform to AASHTO M36.

- C. Type I and Type II inlets shall conform to ASTM A525 except 2.00 ounce coating shall be required.
- D. When specified, pipe, flumes, and inlets shall be bituminous coated conforming to AASHTO M190.
- E. All anchor assemblies, hardware, and accessories shall conform ASTM A153 and ASTM A123.

709.03.08 CORRUGATED METAL PIPE FOR UNDERDRAINS

- A. This pipe shall conform to AASHTO M36, Type III for the specified diameters.
- B. Unless otherwise specified, any 1 of the first 3 classes shown may be furnished.

709.03.09 BITUMINOUS COATED CORRUGATED METAL PIPE FOR UNDERDRAINS

- A. This pipe shall conform to AASHTO M36 and shall be coated with the bituminous material to meet AASHTO M190, Type A coating, except that minimum coating thickness shall be 0.03 inch.
- B. Coupling bands shall be full coated.
- C. The specified minimum diameter for perforations shall apply after coating.

709.03.10 THERMOPLASTIC, PLASTIC PIPE CULVERTS AND DRAINS

- A. Plastics are composed of thermoplastic and thermosetting resins such as acrylonitrile butadiene styrene (ABS), polyethylene (PE), polyvinyl chloride (PVC), fiber-reinforced (CCFRPM or FRP), or saturated fibers (CIPP).
- B. For this specification, the applicable plastics are PE and PVC and are generally identified by cell classification in accordance with AASHTO M294 and M304.
 - 1. The cell classification is a series of numbers and letters that correspond to the ranges of properties in the plastic compound.
 - 2. The pipe strength is expressed as pipe stiffness as psi per linear inch, the product of the initial flexural modulus, and pipe wall cross section moment of inertia.
- C. PE pipe shall conform to AASHTO M252 and AASHTO M294.
- D. PVC pipe shall conform to AASHTO M278 and AASHTO M304.
- E. Thermoplastic pipe shall be fabricated in accordance with this section.
- F. Thermoplastic pipe or end sections greater than a 30-inch diameter shall not be allowed within a minimum of 8 feet of an open outfall.
- G. The thermoplastic material properties shall comply with this section.
- H. Joints shall be specified in accordance with the following Table 2.

Table 2 - Joint Types				
Pipe Type	Joint Type	Description	Test Pressure	Application
Corrugated HDPE (D), (S)	Silt Tight	Bell/Spigot O-Ring	2.0 psi	Storm
Ribbed HDPE, Ribbed PVC, Spiral Wound PVC, Corrugated HDPE, Corrugated PVC	Water Tight (pressure)	Bell/Spigot O-Ring	10.8 psi	Storm

I. Reference specifications:

1. **Corrugated Polyethylene Pipe, Type S:**

- a. Type S corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds with the exception that up to 3 percent grindings from original pipe trimming may be reintroduced.
- b. The pipe shall conform to AASHTO M252 for pipe sizes 4 inches to 10 inches, and AASHTO M294 for pipe sizes 12 inches to 60 inches, unless otherwise specified herein or in the Special Provisions.
- c. The pipe wall shall be corrugated exterior construction with a smooth inner liner.

2. **Corrugated Polyethylene Pipe, Type D:**

- a. Type D corrugated PE pipe shall be manufactured from HDPE virgin compounds with the exception that up to 3 percent grindings from original pipe trimming may be reintroduced.
- b. Nominal sizes of 42 inches through 60 inches shall conform to AASHTO M294, unless otherwise specified herein or in the Special Provisions.
- c. The pipe shall consist of an essentially smooth waterway braced circumferentially or spirally with projections or ribs joined to an essentially smooth outer wall.
- d. Both walls shall be fused to, or continuous with, the internal supports.

3. **Ribbed Profile Wall or Spiral Wound Polyethylene Pipe:**

- a. Ribbed wall PE pipe shall be manufactured from HDPE virgin compounds with the exception that up to 3 percent grindings from original pipe trimming may be reintroduced.
- b. The pipe shall conform to ASTM F894.
- c. The pipe wall shall be of either solid or hollow rib exterior construction with a smooth inner surface.

4. **Ribbed Profile Wall or Spiral Wound Polyvinyl Chloride Pipe:**

- a. Ribbed profile wall PVC pipe shall be manufactured from PVC virgin compounds and shall conform to AASHTO M304, unless otherwise specified herein or in the Special Provisions.
- b. The pipe wall shall be of solid rib exterior construction with a smooth inner surface.

5. **Corrugated Polyvinyl Chloride Pipe with a Smooth Interior:**

- a. Corrugated profile wall PVC pipe shall be manufactured from PVC virgin compounds and shall conform to ASTM F949, unless otherwise specified herein or in the Special Provisions.
- b. The pipe wall shall be corrugated exterior construction with a smooth inner liner.

6. **Solid Wall Polyvinyl Chloride Pipe:**

- a. Solid wall PVC pipe and fittings shall be type PSM PVC pipe and fittings in accordance with ASTM D3034, SDR 35, or ASTM F679 with a T-1 wall thickness or Class P550 PVC pipe and fittings conforming to AASHTO M278.

- b. Additives and fillers shall not exceed 10 parts by weight per 100 parts of PVC resin in the material compound.
- 7. **Acrylonitrile Butadiene Styrene Composite Pipe:**
 - a. Acrylonitrile butadiene styrene (ABS) composite pipe shall conform to AASHTO M264.
 - b. Couplings shall be Type SC.
 - c. The ends of the pipe shall be formed so that, when laid together and jointed, the pipe will form a continuous line with a smooth interior surface.
 - d. Immediately prior to assembling the pipe joints, the exposed cross-sectional ends of the pipe shall be coated with the same adhesive cement used for joining the couplings to the pipe.
- 8. **Special Fittings:**
 - a. Special fittings such as elbows, tees, and wyes for these conduits shall be of the same material as the conduits to which they are joined, and shall conform to applicable requirements for type of material being used.
 - b. When thermoplastic pipe end sections are required, the following requirements shall pertain:
 - 1) End fittings shall be of the sizes shown on the plans.
 - 2) The end of the pipe shall be furnished with corrugation to conform to the end fittings. However, other designs may be used if approved by the Engineer.
 - 3) Where connector fittings are used, the connector fittings shall be helical or annular as required to match the type of pipe used.

709.03.11 CORRUGATED POLYETHYLENE PIPE FOR PERFORATED UNDERDRAINS

- A. Type CP pipe shall conform to AASHTO M252 for nominal sizes of 3 inches through 10 inches, and to AASHTO M294 for nominal sizes of 12 inches through 60 inches.
- B. Type SP pipe shall conform to AASHTO M252 for nominal sizes of 4 inches through 10 inches, and to AASHTO M294 for nominal sizes of 12 inches through 60 inches.

709.03.12 STRUCTURAL PLATE PIPE, ARCHES, AND PIPE ARCHES

- A. This pipe shall conform to AASHTO M167 for steel and to AASHTO M219 for aluminum.

709.03.13 DUCTILE IRON PIPE

- A. This pipe shall conform to ASTM A74, for "Sanitary Sewer Pipe" or with AWWA C151, for "Culinary Water Pipe," as applicable.

709.03.14 STEEL WATER PIPE

- A. This pipe shall conform to AWWA C200.

INSPECTION AND TESTING

709.04.01 PRODUCTION QUALITY CONTROL INSPECTION AND TESTING

- A. Material shall be tested, inspected, and certified in accordance with the frequencies table below and submitted to the Engineer as required in the approved, authorized quality control program.
- B. If the facility is not authorized, then prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and requirements.
1. Test and inspection data shall be included with the certifying document.
 2. Subsequent submittals and reports shall be reviewed by the Contractor for compliance, then transmitted to the Engineer for approval.
- C. The laboratory shall be accredited by American Association for Laboratory Accreditation (A2LA) or by another nationally recognized program approved by the Engineer in the appropriate test method, where applicable.
1. Any structural integrity test shall be reviewed and stamped by a Nevada professional engineer who has responsible charge of the work.
 2. Chemical testing does not require a professional engineer review and stamp.
- D. Review the Clark County web site for any exceptions to the test methods listed below at www.accessclarkcounty.com/depts/public_works/Pages/igac.aspx

Table 3 - Quality Control Inspection and Testing - General				
Product	Subsection	Reference	Requirement	Frequency
Plant QC Program, Plastic Pipe	709.01.01	AASHTO M294, Appendix A and Plastic Pipe Institute or other Agency approved program	Certified annually	1 per new plant or revision
Plant QC Program, Metal Pipe		AASHTO M294, Appendix A and Agency approved program		
All Pipe	709.03.01 through 709.03.14	Applicable AASHTO and/or ASTM standards	Design submittal	1 per type

Table 4 - Plastic PE Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe				
Corrugated PE Pipe, Type S, and Type D	709.03.10.1.1 709.03.10.1.2 709.03.11	Applicable AASHTO standards; AASHTO M252 AASHTO M294 AASHTO M304	Basis of manufactured lot acceptance	See Components below
Ribbed Profile Wall or Spiral Wound PE Pipe	709.03.10.1.3	Applicable AASHTO standards; ASTM F894		

Table 4 - Plastic PE Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Components				
Pipe Raw Material		ASTM D1505 ASTM D1238 ASTM F2136 AASHTO M294	Resin Test, Density, Melt Index, SP-CLS Test, ESCR Test 32-hour	1 per lot
Gasket		Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	
Pipe		AASHTO M294 ASTM D638 ASTM D790	Pipe Stiffness, Flattening, and Brittleness tests, Elongation, Tensile Strength, Modulus of Elasticity, Unit Weight	3 per week or 1 per lot, whichever is greater
		ASTM D5397	NCTL Test	1 per lot
		AASHTO M294	ESCR Test	
Pipe Joint		ASTM D3212	Joint Hydrostatic Test	1 per setup or change
		AASHTO M294	Joint Shear Test	
Inspection		AASHTO M294 ASTM D2122 ASTM F894	Wall Thickness, Inside Diameter, Length, Markings	Each piece

Table 5 - PVC Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe				
Ribbed Profile Wall or Spiral Wound PVC Pipe, Corrugated PVC	709.03.10.I.4	Applicable AASHTO standards; AASHTO M304; ASTM F949, Section 10.E	Basis of manufactured lot acceptance	See Components below
Solid Wall PVC Pipe	709.03.10.I.6	Applicable AASHTO standards; ASTM D3034, SDR 35, or ASTM F679		
Components				
Pipe Raw Material		ASTM D1505 ASTM D1238 ASTM F2136	Resin Test, Density Melt Index, SP-NCLS Test	1 per lot
		AASHTO M304, ASTM F2136	ESCR Test 32-hour	
Gasket		Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	

Table 5 - PVC Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe		AASHTO M304	Pipe Stiffness, Flattening, and Brittleness tests, Elongation, Tensile Strength, Modulus of Elasticity, Unit Weight	3 per week or 1 per lot, whichever is greater
		ASTM D2152	Acetone Immersion	1 per lot
		ASTM D5397	NCTL Test	
		AASHTO M264	ESCR Test	
Pipe Joint		ASTM D3212	Joint Hydrostatic Test	1 per setup or change
		AASHTO M304	Soil Tight Joint	
Inspection		AASHTO M304 and ASTM D2122, ASTM D3034, or ASTM F679	Wall Thickness, Inside Diameter, Length, Markings	Each piece

Table 6 - ABS Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe				
ABS Composite Pipe	709.03.10.I.7	Applicable AASHTO standards; AASHTO M264 (ASTM D2680)	Basis of manufactured lot acceptance	See Components below
Components				
Pipe Raw Material		ASTM D1505 ASTM D1238 ASTM F2136	Resin Test, Density, Melt Index, SP-NCLS Test	1 per lot
		ASTM D1693 ASTM F2136	ESCR Test 32-hour	
		ASTM D2152	Extrusion Quality	
Gasket		Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	
Pipe		AASHTO M264 ASTM D2412 ASTM D638 ASTM D790	Pipe Stiffness, Flattening, and Brittleness tests, Elongation, Tensile Strength, Modulus of Elasticity, Unit Weight	3 per week or 1 per lot, whichever is greater
		ASTM D2152	Acetone Immersion	1 per lot
		ASTM D5397	NCTL Test	
		AASHTO M264	ESCR Test	
Pipe Joint		ASTM D3212	Joint Hydrostatic Test	1 per setup or change
Inspection		ASTM D2680 ASTM D2122	Wall Thickness, Inside Diameter, Length, Markings	Each piece

Table 7 - Metal Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe				
Corrugated Metal Pipe and Pipe Arches (and Bituminous Coated)	709.03.01 709.03.02 709.03.05 709.03.06 709.03.07 709.03.08 709.03.09	Applicable AASHTO/ASTM standards; AASHTO M36 or AASHTO M196	Basis of manufactured lot acceptance	See Components below
Aluminized Type II Coated Corrugated Steel Pipe	709.03.03	Applicable AASHTO/ASTM standards;		
Corrugated Aluminum Pipe	709.03.04	Applicable AASHTO/ASTM standards;		
Concrete Lined Corrugated Steel Pipe	709.03.06	Applicable AASHTO/ASTM standards;		
Structural Plate Pipe and Pipe Arches	709.03.12	Conform to the Contract Special Provisions		
Ductile Iron Pipe	709.03.13			
Steel Water Pipe	709.03.14			
Components				
Pipe Raw Material		AASHTO M218 and ASTM A924	Certification of Tension Test and Base Metal Analysis, Corrugated Metal Pipe and Pipe Arches	1 set per lot
		AASHTO M274 and ASTM A463	Certification of Tension Test and Base Metal Analysis, Aluminized Type II Coated Corrugated Steel Pipe	
		AASHTO M218	Certification of Tension Test and Base Metal Analysis, Concrete Lined Corrugated Steel Pipe	
		AASHTO M196 AASHTO M197 ASTM B209	Certification of Tension Test and Base Metal Analysis, Corrugated Aluminum Pipe	
Sheet (Coil)		AASHTO M197 AASHTO M218 AASHTO M274	Thickness	Each coil
Corrugation		AASHTO M36, Section 7.2	Profile	Each setup
Band MTLS		AASHTO M36 Section 9	Thickness and Width	
Lock Seam		AASHTO T249	Inspection and Tensile Test	Each day

Table 7 - Metal Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe Coating		AASHTO M218 AASHTO M190 AASHTO T65 ASTM A754	Thickness (Corrugated Metal Pipe and Pipe Arches including Bituminous Coated)	Each piece
		AASHTO M274 AASHTO T213 or ASTM A754	Supplier Certificate of Thickness for Corrugated Aluminum, Aluminized Steel, and Concrete-Lined Steel (excluding water pipe)	Per lot
Pipe		AASHTO M218 ASTM A924	Thickness, Diameter (Corrugated Metal Pipe and Pipe Arches including Bituminous Coated)	Each piece
Pipe Inspection		AASHTO M36 Section 8.1.1	Dimensions	Each setup per shift
		AASHTO M36 Section 9 AASHTO M196 Section 10.1	Workmanship	Each piece
Pressure Pipe Joint		ASTM D3212	Hydrostatic Test	1 per setup or change

SECTION 714

PAINT AND PAVEMENT MARKINGS

SCOPE

714.01.01 MATERIALS COVERED

- A. This specification covers the quality, color, and number of applications of paint used for painting the various materials of construction.
 - 1. The raw materials for use in the various paint formulas shall conform to the specifications designated by federal or military serial number or paint material code number under the various paint classifications hereinafter specified.
 - 2. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products.
 - 3. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer.
 - 4. State specification numbers referred to are California State Specifications unless otherwise noted.
- B. Comply with Section [715](#), "Galvanizing," for galvanized coatings.

REQUIREMENTS

714.02.01 CERTIFICATES

- A. The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials tested comply with all of the requirements. Samples will be taken when required by the Engineer.
- B. Prior to using any material, the Contractor shall provide the Engineer with a written "Certification of Compliance" from the manufacturer of the material. The certification shall:
 - 1. Include the manufacturer's name, business address, and location of the manufacturing plant.
 - 2. Identify the specifications and include 1 copy.
 - 3. Show the quantity of materials supplied for each color, batch number, and date of manufacture.
- C. Manufacturer's lab test results shall be supplied upon request of the Engineer. No pavement marking material shall be used which is not on the Qualified Products List (QPL) established by the Nevada Department of Transportation (NDOT). The current NDOT QPL is available at http://www.nevadadot.com/reports_pubs/QPL/.

PHYSICAL PROPERTIES AND TESTS

714.03.01 IRON AND STEEL USE ITEM CLASSIFICATIONS

- A. **Zinc-Rich Primer, Organic Vehicle Type (State Spec. 8010-61J-36):**
 - 1. This specification covers a 1-package, thermoplastic, organic zinc-rich primer whose mechanism of drying is that of solvent release.

2. This primer is intended for use only on blast cleaned open steel structures exposed to the air.
 3. This coating is intended for spray application. Limited application can be made by brushing.
- B. Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27):**
1. This specification covers a wash primer formulated specifically for application prior to painting clean aluminum, galvanized surfaces, or surfaces previously coated with an organic or inorganic zinc-rich primer.
 2. This primer is also used on blast cleaned steel when specified and is mandatory as an undercoat under vinyl paint systems.
- C. Vinyl Primer, Red Iron Oxide Type (State Spec. 8010-61J-23):**
1. This specification covers a ready-mixed, vinyl-red oxide paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment Vinyl Wash Primer (State Spec. 8010-61J-27).
 2. This paint should be applied alternately with Vinyl Primer, Red Iron Oxide - Titanium Dioxide Type (State Spec. 8010-61J-24) to provide a primer coating which may consist of 1 or more applications of each vinyl primer.
 3. Either State Specification 8010-61J-23 or 8010-61J-24 may be used for the initial application.
 4. This paint is formulated primarily for spray application.
- D. Aluminum Vehicle Varnish (State Spec. 8010-91B-75):**
1. This specification covers an aluminum vehicle clear varnish and general all purpose phenolic base spar mixing varnish.
 2. This varnish should not be used on surfaces and in pigment combinations where yellowing will be objectionable.
- E. Aluminum Paint, Finish Coat, (State Spec. 8010-61J-45):**
1. This specification covers a phenolic resin varnish base aluminum paint, suitable for use as a finish coat.
 2. This paint is formulated for use on structural steel and interior and underwater surfaces of steel water tanks and similar exposed surfaces.
 3. This paint shall be furnished in 2-compartment containers and shall be mixed fresh each day.
- F. Vinyl Paint, Aluminum Finish Coat (State Spec. 8010-61J-25):**
1. This specification covers a vinyl type aluminum paint for use on properly prepared metal surfaces that have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27) or specified vinyl undercoats.
 2. This paint is primarily formulated for spray application.
 3. This paint shall be furnished in 2-compartment containers and shall be mixed fresh each day.

G. Burnt Umber Tint Finish Coat (State Spec. 8010-61J-41):

1. This specification covers a ready-mixed burnt umber tint paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

H. Burnt Sienna Finish Coat (State Spec. 8010-61J-53):

1. This specification covers a ready-mixed burnt sienna paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

I. Green Finish Coat (State Spec. 8010-61J-47):

1. This specification covers a ready-mixed green paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

J. Vinyl Green Finish Coat (State Spec. 8010-61J-40):

1. This specification covers a ready-mixed green vinyl finish paint for use on properly prepared metal surfaces that have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27), or specified vinyl undercoats.
2. This paint is formulated primarily for spray application.

K. Vinyl Iridescent Green Finish Coat (State Spec. 8010-91B-43):

1. This specification covers a ready-mixed iridescent green vinyl finish paint for use on properly prepared metal surfaces that have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27), or specified vinyl undercoats.
2. This paint is formulated primarily for spray application.

L. Tan Finish Coat (State Spec. 8010-61J-51):

1. This specification covers a ready-mixed, tan paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

M. White Tint Base Finish Vinyl Coat (State Spec. 8010-71C-35):

1. This specification covers a ready-mixed, white tint base, vinyl finish paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).
2. This paint is formulated primarily for spray application.

N. Enamel; Exterior White, Metal (State Spec. 8010-61J-09):

1. This specification covers a fast drying, exterior, white enamel, primarily for use on metal, or for other exterior surfaces where gloss and durability are requisite.
2. This paint shall conform to the provisions of Military Specification MIL-E-1115A.

O. Enamel; Traffic Signal, Lusterless, Black (State Spec. 8010-61J-13):

1. This specification covers a lusterless, black enamel for use in painting traffic signal hoods, shields, and other surfaces.

2. When used on bare aluminum or zinc, Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27) shall be used first to ensure proper bond.
- P. Enamel; Traffic Signal, Dark Olive Green (State Spec. 8010-41B-A):**
1. This specification covers an enamel for use on signal poles.
 2. This paint is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).
- Q. Enamel; Traffic Signal, Yellow (School Bus Yellow):**
1. This specification covers high-gloss enamel for use on signal poles.
 2. This paint is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).
 3. School bus yellow shall conform to Federal Color No. 13432 as shown in Table V of Federal Standard No. 595a.
- R. Enamel; Traffic Signal, Silver:**
1. This specification covers an enamel for use on signal poles.
 2. This paint is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).
 3. The silver shall conform to Federal Color No. 17178 as shown in Table IX of Federal Standard No. 595a.

714.03.02 TIMBER USE ITEM CLASSIFICATIONS

- A. Wood Primer Latex Base:**
1. This specification covers a ready-mixed, priming paint for use on unpainted wood or exterior wood work.
 2. This paint shall comply, in all respects, with Federal Specification TT-P001984, except that it shall dry hard in not more than 12 hours.
- B. Paint, Latex Base for Exterior Wood, White and Tints:**
1. This specification covers a ready-mixed paint for use on wood surfaces subject to outside exposures.
 2. This paint shall comply in all respects with Federal Specification TT-P96D.
 3. Unpainted wood shall first be primed with Wood Primer conforming to Subsection [714.03.02](#), paragraph A, "Wood Primer, Latex Base."
- C. Enamel; Sign Post, Black (State Spec. 8010-61J-08):**
1. This specification covers a gloss black enamel for use on wood or metal.

714.03.03 CONCRETE USE ITEMS

- A.** Concrete end posts (bridges), raised traffic bars, and miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formulated or Specification
Finish	1	White	Water Thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion

714.03.04 ALUMINUM USE ITEM

- A. Aluminum bridge railing and posts specified to receive paint shall be prepared for painting with a coat of Pre-Treatment, Vinyl Wash Primer conforming to Subsection [714.03.01](#), paragraph B, "Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27)."
- B. The Contractor may use any of the paint systems specified for use on iron or steel in Subsection [714.03.01](#), "Iron and Steel Use Item Classifications," for painting aluminum, and shall submit to the Engineer for approval a letter indicating Contractor's choice of system as required for iron or steel.

714.03.05 PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING, AND CURB MARKING - GENERAL

- A. These specifications are intended to cover ready-mixed paints of a consistency suitable for use on highway pavements and curbing, either asphaltic or Portland cement concrete type.
- B. Reference specifications and standards shall be Federal Specifications, latest revision, as herein noted, or Federal Test Method Standard No. 141, latest revision, as called for and amended in these specifications.
- C. Paint shall be homogenous, free of contaminant, and of a consistency suitable for use in the capacity for which it is specified.
 - 1. Finished paint shall be well ground and the pigment shall be properly dispersed in the vehicle according to the requirements of the paint.
 - 2. The dispersion shall be of such nature that the pigment does not settle badly, does not cake or thicken in the container, and does not become granular or curdled.
 - 3. Any settlement of pigment in the paint shall be a thoroughly wetted soft mushy mass permitting the complete and easy vertical penetration of a paddle.
 - 4. Settled pigment shall be easily redispersed, with minimum resistance to the smooth uniform product of the proper consistency.
 - 5. The manufacturer shall include in the paint the necessary additives for control of sagging, pigment settling, leveling, drying, drier absorption and skinning, or other requisite qualities of a satisfactory working material.
 - 6. The paint shall possess satisfactory properties, in all respects, that affect its application and curing.
- D. All manufactured paint shall be prepared at the factory ready for application. The addition of thinner or other material to the paint after the paint has been shipped will not be permitted unless otherwise specified in the contract Special Provisions.

714.03.06 PAVEMENT MARKINGS

- A. **Type 2:**
 - 1. Type 2 pavement marking material shall be a durable retroreflective pavement marking for use on asphalt or concrete pavements transverse markings such as crosswalks and stop bars, and for word/symbol markings, that are subjected to severe wear conditions such as repeated shear action from stop, start, or turn movements.
 - 2. Type 2 materials are as follows:
 - a. **Preformed Pavement Marking Tape:** This material shall meet the minimum requirements set forth in ASTM D4505 except as modified below.

- b. Whiteness Index: The daylight color of the white striping shall have a minimum initial whiteness index of sixty (60) as determined in Practice E313. Color shall be determined using 0/45 or 45/0 geometry.

c. Retroreflectance:

- 1) White preformed marking tape shall have the following initial minimum retroreflectance values as measured in accordance with ASTM D4061.
- 2) Retroreflectance values shall be expressed as coefficient of retroreflected luminance (R_L) in millicandelas per square foot per footcandle ($\text{mcd}/\text{ft}^2/\text{fc}$).

Entrance Angle	86.0°	86.5°	88.8°
Observance Angle	0.2°	1.0°	1.05°
R_L ($\text{mcd}/\text{ft}^2/\text{fc}$)	550	300	250

- d. Skid Resistance: The surface of the retroreflective pavement marking tape shall provide an initial minimum average skid resistance value of 45 BPN when tested in accordance with ASTM E303.

e. Durability:

- 1) The durability of the pavement marking material shall be the percentage of the marking material remaining on the pavement surface in satisfactory working condition.
- 2) The initial value shall always be established at 100 percent.

f. Performance Requirements:

- 1) Type 2 pavement marking material, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to the temperature if the pavement surface remains stable.
- 2) The material shall be weather resistant and, through normal traffic wear, shall show no fading that will significantly impair the intended use of the marking throughout its useful life.
- 3) Pavement marking tape shall show no lifting or shrinkage and shall show no significant tearing, roll back, or other signs of poor adhesion.
- 4) Type 2 pavement marking material shall also meet the performance criteria establish in the table below.

Performance Factor*	Heavy Traffic (greater than 6,000 ADT per lane)	Medium and Light Traffic (6,000 ADT or less per lane)
Retained Retroreflectivity	74	40
Durability	90%	75%
Whiteness Index	10	10
Whiteness Index (0.5 million vehicle passes)	20	20

*Values for the performance factors are retained values which shall be determined after the markings have been in place a minimum of one (1) year and subjected to a minimum 4,000,000 vehicle passes per lane.

g. Installation and Warranty

- 1) The markings shall be applied in accordance with the manufacturer's instructions.
- 2) Contractor shall provide to Engineer the manufacturer's written installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.
- 3) The marking material and installation shall have a minimum 1-year warranty.

B. **Type 1:**

1. Type 1 pavement marking material shall be a durable retroreflective pliant pavement marking for use on asphalt or concrete pavements for longitudinal markings such as edge lines and lane lines.
2. The color of the marking material shall be white or yellow and conform to standard highway colors.
3. Type 1 materials shall be as follows

- a. **Preformed Pavement Marking Tape:** This material shall meet minimum requirements set forth in ASTM D4505 except as modified below:

1) Retroreflectance:

- a) White and yellow preformed marking tape shall have the following initial minimum retroreflectance values as measured in accordance with the testing procedures of ASTM D4601.
- b) Retroreflectance values shall be expressed as coefficient of retroreflected luminance (RL) in millicandelas per square foot per footcandle (mcd/ft²/fc).

	White			Yellow		
Entrance Angle	86.0°	86.5°*	88.8°	86.0°	86.5°*	88.8°
Observance Angle	0.2°	1.0°	1.05°	0.2°	1.0°	1.05°
R _L (mcd/ft ² /fc)	800	600	400	700	500	300

- 2) Skid Resistance: The surface of the retroreflective pavement marking tape shall provide an initial minimum average skid resistance value of 45 BPN when tested in accordance with ASTM E303.

b. **Preformed Thermoplastic Tape (Yellow Markings Only):**

- 1) The preformed retroreflective marking material shall consist of a resilient polymer thermoplastic with uniformly distributed retroreflective beads throughout its entire cross section.
- 2) The markings shall be fusible to asphalt and Portland cement concrete pavements by the normal heat of a propane torch as recommended by the manufacturer.

c. **Paint:**

- 1) Traffic paint used for pavement markings shall conform to material requirements listed in the following subsections:

- a) Subsection [714.03.05](#), "Paint for Traffic Striping, Pavement Marking, and Curb Marking - General,"
- b) Subsection [714.03.07](#), "Fast Dry Traffic Paint,"
- c) Subsection [714.03.09](#), "Ready-Mixed Traffic Stripe Paints."
- 2) Requirements for retroreflective beads used with the application of this material are listed in Subsection [714.03.12](#), "Reflective Material."
- d. **Epoxy Paint (Yellow Marking Only):**
 - 1) Epoxy paint marking material shall consist of a 100 percent solid, 2-part system formulated and designed to provide a simple volumetric mixing ratio of 2 components.
 - 2) Epoxy paint used for pavement markings shall conform to materials requirements listed in Subsection [714.03.10](#), "Epoxy Paint for Traffic Markings."
 - 3) Requirements for retroreflective beads used with the application of this material are listed in Subsection [714.03.12](#), "Reflective Material."
- e. **Polyurea Paint:**
 - 1) Polyurea paint marking shall consist of a 100 percent solid, 2-part system formulated and designed to provide a simple volumetric mixing ratio of 2 components.
 - 2) Polyurea paint used for pavement markings shall conform to materials requirements listed in Subsection [714.03.10](#), "Epoxy Paint for Traffic Markings."
 - 3) Requirements for retroreflective beads and reflective elements used with the application of this material are listed in Subsection [714.03.12](#), "Reflective Material."
- f. **Durability:**
 - 1) The durability of the pavement marking material shall be the percentage of the marking material remaining on the pavement surface in satisfactory working condition.
 - 2) The initial value shall always be established at 100 percent.
- g. **Performance Requirements:**
 - 1) Type 1 pavement marking material, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to the temperature if the pavement surface remains stable.
 - 2) The material shall be weather resistant and, through normal traffic wear, shall show no fading that will significantly impair the intended use of the marking throughout its useful life.
 - 3) Pavement marking tape shall show no lifting or shrinkage and shall show no significant tearing, roll back, or other signs of poor adhesion.
 - 4) Type 1 pavement marking material shall also meet the performance criteria established in the table below.

Performance Factors	Heavy Traffic (greater than 6000 ADT per lane)		Medium and Light Traffic (6000 ADT or less per lane)	
	White	Yellow	White	Yellow
Retained Retroreflectivity	200	150	100	100
Durability	98%	95%	93%	93%
Whiteness Index	6	45	6	40

*Values for the performance factors are retained values which shall be determined after the markings have been in place a minimum of one (1) year and subjected to a minimum 4,000,000 vehicle passes per lane.

h. Installation and Warranty:

- 1) The markings shall be applied in accordance with the manufacturer's instructions.
- 2) Contractor shall provide to Engineer the manufacturer's written installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.
- 3) The marking material and installation shall have a minimum 1-year warranty.

i. Qualified Products List:

- 1) The Nevada Department of Transportation (NDOT) maintains a Qualified Products List (QPL) of all products available that satisfy the requirements of these specifications and have proven effective in field tests. The current NDOT QPL is available at: http://www.nevadadot.com/reports_pubs/QPL/.

714.03.07 FAST DRY TRAFFIC PAINT

- A. Type 2 (Heatable) Fast Dry White, Type 2 (Heatable) Fast Dry Yellow, Type 1 Fast Dry White, and Type 1 Fast Dry Yellow shall comply with any western state specification valid at the time of use in addition to meeting Subsection [714.03.05](#), "Paint for Traffic Striping, Pavement Marking, and Curb Marking – General, and listed on the NDOT QPL.
- B. Fast dry traffic paint shall be applied at the film thickness of 15 mils to 20 mils and shall dry to "no traffic pickup" within 3 minutes.
- C. The "no traffic pickup" time shall be determined by ASTM D711.

714.03.08 ALL PURPOSE BLACK TRAFFIC PAINT - PAINT FORMULA 235

- A. All purpose Black Traffic Paint - Paint Formula 235 shall comply with any western state specification valid at the time of use, and listed on the NDOT QPL.

714.03.09 READY-MIXED TRAFFIC STRIPE PAINTS

- A. Where ready-mixed paints are specified, they shall be suitable for use on either asphalt concrete or Portland cement concrete.

714.03.10 EPOXY PAINT FOR TRAFFIC MARKINGS

- A. Epoxy traffic paints shall be a 2-component marking material suitable for use on either asphalt concrete or Portland cement concrete.
- B. Mixing of 2 components shall be performed as recommended by the manufacturer.

- C. Epoxy paint shall only be applied if air temperature is a minimum of 50 degrees F at the time of marking installation.
- D. If the manufacturer of the marking material requires a minimum air temperature different than detailed above, the higher temperature shall be used.
- E. If material needs heating prior to application, no fumes shall be exuded that are toxic or injurious to persons or property.
- F. Epoxy paint shall dry to "no traffic pickup" within 45 minutes.

714.03.11 POLYUREA PAINT FOR TRAFFIC MARKINGS

- A. Polyurea traffic paints shall be a 2-component marking material suitable for use on either asphalt concrete or Portland cement concrete.
- B. Mixing of 2 components shall be performed as recommended by the manufacturer.
- C. Polyurea paint shall be applied if air temperature is a minimum of 40 degrees F at the time of marking application.
- D. If the manufacturer of the marking material requires a minimum air temperature different than detailed above, the higher temperature shall be used.
- E. If material needs heating prior to application, no fumes shall be exuded that are toxic or injurious to person or property.
- F. Polyurea paint shall be dry to "no traffic pickup" within 5 minutes.

714.03.12 REFLECTIVE MATERIAL

- A. Reflective material shall consist of retroreflective beads and of the final coat of traffic paint or epoxy paint and polyurea paint prior to setting, so that the beads will have proper adhesion.
- B. Special care shall be taken with rapid dry paint and epoxy paint materials.
- C. Retroreflective beads shall conform to Federal Specification TT-B-1325B and shall be mechanically applied at a rate recommended by the manufacturer to achieve performance criteria established in Section [714.03.06](#), "Pavement Markings."
- D. Retroreflective beads shall be applied to pavement markings, curbs, and crosswalks by use of a dispensing device developed for this purpose or other methods approved by the Engineer.
- E. The Engineer may authorize the use of traffic paint containing pre-mixed retroreflective beads.
 - 1. The type, gradation, quantity, and quality of the pre-mixed retroreflective beads shall be approved prior to the manufacture of the traffic paint.
 - 2. In addition to the specified pre-mixed beads, additional beads may need to be mechanically applied when the traffic paint is applied.

714.03.13 AIR POLLUTION

- A. All paint shall meet the requirements of the Clark County Department of Air Quality and Environmental Management (DAQEM).

714.03.14 TEST REPORTS AND CERTIFICATION

- A. At the time of delivery of each shipment of material, the Contractor shall, upon request, deliver to the Engineer certified copies of the manufacturer's test report.
- B. The test report shall indicate the name of the manufacturer, type of material, date of manufacture, quantity, applicable State Specification Number and specification, manufacturer's lot or batch number, and results of the required tests.
 - 1. The test report shall be signed by an authorized representative of the manufacturer.
 - 2. The certified test reports and the testing required in connection therewith shall be at no cost to the Contracting Agency.

SECTION 725**ELASTOMERIC BEARING PADS****SCOPE****725.01.01 MATERIALS COVERED**

- A. Elastomeric bearing pads shall be preformed pads formed by casting or extruding natural rubber or neoprene under pressure and heat.
- B. The pads shall be cast or extruded in a single, integral layer to the required thickness, unless pads with nonelastic lamination are called for on the plans.
- C. All components of a laminated pad shall be molded together into an integral unit and all edges of the laminates shall be covered by a minimum of 1/8 inch of elastomer, except at laminate restraining devices and around holes that will be entirely closed on the finished structure.
- D. Laminates shall be of the material and thickness called for on the plans.

REQUIREMENTS**725.02.01 CERTIFICATE OF INSPECTION**

- A. The material furnished will be evaluated for acceptance on the basis of the manufacturer's Certified Report of Test or Analysis indicating compliance with these special properties, but the Engineer may obtain test specimens on request.
- B. Contractor shall furnish to the Engineer 3 copies of the manufacturer's Certified Report of Test or Analysis before use of the material in the work.
- C. Test specimens, when required, shall be in accordance with ASTM D15, Part B.

PHYSICAL PROPERTIES AND TESTS**725.03.01 GENERAL**

- A. The pads shall conform to the following physical properties:

	Natural Rubber	Neoprene
Grade (Durometer)	60	60
Physical Properties:		
Hardness, (ASTM D 2240)	60 ±5	60 ±5
Tensile Strength, min. psi, (ASTM D412)	2,500	2,500
Ultimate elongation, min. percent	400	350
Heat Resistance, 70 hours at 158°F (ASTM D573):		
Hardness, max. points change	10	15
Tensile strength, max. percent change	-25	-15
Ultimate elongation, max. percent change	-25	-40
Compression Set (ASTM D395, Method B):		
22 hours at 158°F, max. percent	25	--
22 hours at 212°F, max. percent	--	35

	Natural Rubber	Neoprene
Ozone (ASTM D1149), 20 percent strain 100°F ±2°F, mounting procedure ASTM D518, Procedure A:		
225 pphm ozone in air by volume, 48 hours	No cracks	---
100 pphm ozone in air by volume, 100 hours	--	No cracks
Adhesion (ASTM D429, Method B):		
Bonds made during vulcanization, pounds per inch	40	40

SECTION 726
ROADSIDE MATERIALS

SCOPE

726.01.01 MATERIALS COVERED

- A. This specification covers the materials used in erosion control, landscaping, and irrigation systems.

REQUIREMENTS

726.02.01 CERTIFICATES AND SAMPLES

A. Planting Soil:

1. Before imported planting soil is brought on the jobsite, a 10-pound sample shall be submitted to the Engineer for approval.
2. The sample shall be accompanied by a current report, furnished by the Contractor, from a recognized testing laboratory indicating the particle size, clay content, the pH factor, electrical conductivity, and analysis of salt concentrate.

- B. **Fertilizer:** The fertilizer containers shall have the manufacturer's guaranteed statement of analysis clearly marked, all in accordance with state and federal laws.

C. Organic Material:

1. Before bulk organic material is brought to the jobsite, a 10-pound sample shall be submitted to the Engineer for approval.
2. The sample shall be accompanied by a current report, furnished by the Contractor, from a recognized testing laboratory indicating the moisture retention capacity, organic matter (based on dry weight), mineral matter (ash), silica (acid insoluble ash), nitrogen (based on dry weight), pH factor, and the amount of Douglas Fir bark.

D. Plants:

1. All plants shall be nursery grown, healthy, vigorous, well-rooted, shall be true to type or name as shown on the plans, and shall conform to ANSI Z60.1, No. 1 grade.
2. Plants shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.
3. All plants shall comply with federal and state laws requiring inspection for plant diseases and infestations.
4. Inspection certificates required by law shall accompany each shipment of plants, and all plant shipments shall be inspected and passed by the Nevada Department of Agriculture.
5. All shipments of pine nursery stock shall meet all applicable state and federal quarantine regulations.

- E. **Seeds:** The Contractor shall furnish to the Engineer duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within 6 months before the date of delivery on the project.

F. Irrigation Materials:

1. The Contractor shall ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency.
2. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

G. All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TESTS**726.03.01 PLANTING SOIL**

- A. Planting soil shall consist of friable soil of loamy character.
- B. The soil shall be obtained from well-drained arable land and shall be free from subsoil, refuse, roots, heavy or stiff clay, stones larger than 1 inch in largest dimension, coarse sand, sticks, brush, litter, and other deleterious substances.
- C. Requirements for planting soil shall be as follows:

Organic Matter	0.1 to 1.0% by dry weight of soil
Particle Size	3/8 inch (0.953 centimeters) maximum
Clay Content	20% maximum (by weight)
pH Factor	6.5 to 8.0
Electrical Conductivity	0.5 to 1.0 mmhos. per centimeter of the saturation paste extract

726.03.02 FERTILIZER

- A. Fertilizer and agricultural minerals shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified in the contract documents.
 1. Fertilizer may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid, and water-soluble potash in the amounts specified.
 2. All fertilizers and agricultural minerals shall be furnished in standard, unopened containers with weight, name of plant nutrients, and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with state and federal laws.
- B. Acceptable commercial fertilizer and agricultural minerals will be specified in 1 of the following forms:
 1. A dry, free-flowing, granular material suitable for application by agricultural fertilizer spreaders.
 2. A soluble fertilizer and agricultural mineral ground to a fineness that will permit complete suspension of insoluble particles in water, suitable for application by power sprayers.
 3. A granular or pelleted fertilizer and agricultural mineral suitable for application by blower equipment.
 4. A non-volatile liquid fertilizer or agricultural mineral.

726.03.03 ORGANIC MATERIAL

- A. Organic matter shall be processed, composted, fine-ground bark of White Fir, Pine, or Redwood, or a mixture of these in any proportion.
- B. Organic matter shall be free of lumps and clods and shall be fine enough so that 100 percent of the material will pass a 1/2-inch screen and 85 percent will pass a No. 6 screen.
- C. Requirements for organic material shall be as follows:

Moisture Retention Capacity	35 percent minimum
Organic Matter Based on Dry Weight	95 percent minimum
Mineral Matter (Ash)	5 percent maximum
Silica (Acid Insoluble Ash)	3 percent maximum
Nitrogen Based on Dry Weight	0.8 percent minimum
pH Value Based on 1:5 Solution	4.0 to 6.0 maximum
Douglas Fir Bark	0 percent

726.03.04 MULCH**A. Hay or Straw:**

- 1. All hay or straw mulch materials shall be in an air-dried condition free of noxious weeds, weed seeds, and other materials detrimental to plant life.
- 2. Unless otherwise specified in the contract documents, hay or straw mulch material shall be of approved field grasses or legumes indigenous to the area.

- B. Mulch shall also conform to the following requirements:

Moisture Content	12.0% ± 3.0%
Organic Matter (Oven-Dried Basis)	99.6% ± 0.2%
Ash Content	0.8% ± 0.2%
Water Holding Capacity (Grams of Water/ Grams of Fiber)	1,150 minimum

C. Wood Cellulose Fiber:

- 1. Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors.
- 2. Mulch shall be dyed a suitable color to facilitate inspection of the placement of the material.

D. Wood Chips and Shavings:

- 1. Wood chips and shavings shall be manufactured from any clean wood free of infestations.
- 2. Chips from kiln-dried or air-dried material will not be acceptable.
- 3. Chips shall be produced by machinery equipped with knives or blades which cut rather than shred or break the material.
- 4. Chips shall be graded so that substantially all chips are from 1/2 inch to 3 inches in length, 1/2 inch to 1-1/2 inches in width, and from 1/8 inch to 1/2 inch in thickness.

E. Bark:

1. Bark shall be 100 percent bark derived from the bark of White Fir, Red Fir, or Pine and shall contain no Douglas Fir.
2. The bark shall be granular or chunky in nature with all particles between 1-1/4 inches and 2-1/2 inches in diameter.

726.03.05 JUTE MATTING

- A. Jute matting shall be of a uniform, open, plain weave of undyed and unbleached single jute yarn.
- B. The yarn shall be of a loosely twisted construction and shall not vary in thickness by more than 1/2 its normal diameter.
- C. Jute matting shall be furnished in rolled strips as follows:
 1. Length shall be approximately 50 yards.
 2. Matting width shall be 48 inches with an average weight of 0.92 pounds per square yard. A tolerance of ± 1 inch in width and of 5 percent in weight will be allowed.

726.03.06 PLANTS

- A. All plants shall be nursery grown, representative specimens of their species, and shall be true to type or name as shown on the plans.
- B. All plants shall be uniform in growth, in healthy condition, and free from insects, pests, diseases, and injuries, and without evidence of being or having been in a wilted condition.

726.03.07 SEEDS

- A. Grasses, legumes, or cover crop seed shall be furnished in standard containers on which shall be shown the following information:
 1. Date of Test.
 2. Seed Name.
 3. Lot Number.
 4. Net Weight.
 5. Percentage of Purity.
 6. Percentage of Germination (in the case of legumes, percentage of germination shall include hard seed).
 7. Percentage of Weed Seed Content and Inert Material, clearly marked for each kind of seed, in accordance with applicable state and federal laws.
 8. No noxious weed seed present.
- B. Seed that has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.
- C. Seed shall be at least 95 percent pure and shall have a minimum of 85 percent germination.

726.03.08 TREE TIES

- A. Tree ties shall be strips of vinyl-coated nylon, durable, non-hardening, long-life material approximately 1 inch wide and approximately 10 mils thick, or other suitable material approved by the Engineer.
- B. A 10-gauge galvanized wire encased in at least 1/2-inch rubber hose may be used when permitted by the Engineer.

726.03.09 PIPE AND FITTINGS**A. Plastic Pipe:**

- 1. Plastic pipe, shall be PVC 1120 or 1220 pressure pipe as shown in the irrigation system legend on the plans.
 - 2. All PVC pipe shall be extruded from 100 percent virgin material and shall be NSF approved, except plastic pipe for soaker lines shall be flexible PVC conforming to ASTM D2287.
 - 3. Fittings for PVC plastic pipe shall be rigid polyvinyl chloride, standard weight, Schedule 40, and shall be solvent weld type except as shown on the plans.
 - 4. Fittings for PVC pipe shall have higher bursting pressure than the pipe.
 - 5. All plastic pipe shall be continuously and permanently marked with the following information:
 - a. Manufacturer's name and trademark.
 - b. Pipe size.
 - c. Pipe class.
 - d. Type of pipe.
 - e. Working pressure at 73.4 degrees F.
 - f. National Sanitation Foundation (NSF) rating.
 - 6. All PVC plastic pipe shall be homogeneous throughout; smooth inside and outside; and free from cracks, holes, foreign materials, dents, wrinkles, and blisters.
- B. **Delivery:** Plastic pipe shall be delivered to the site in unbroken bundles packaged to provide adequate protection for the pipe ends.

726.03.10 CONTROL TUBING

- A. Control tubing shall be PVC tubing meeting NSF rating in the size specified on the plans.

726.03.11 GATE VALVES

- A. Gate valves, when called for on the plans, shall be heavy-duty bronze conforming to ASTM B62.

726.03.12 QUICK COUPLER VALVES

- A. Quick coupler valves shall have a service rating not less than 150 psi for non-shock cold water.
- B. Body of the valves shall be a single-piece construction of sand-cast semi-red brass alloy No. 5-A as given in ASTM B584.

726.03.13 MASONRY

- A. Hollow load-bearing concrete masonry blocks shall conform to ASTM C90.
- B. Hollow non-load-bearing concrete masonry blocks shall conform to ASTM C129.