

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

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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) FILLER

- 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) FILLER

- 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) FILLER

- 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 ±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		
	707.03.05	Table 2 requirements		
	707.03.05			
Joint Filler	707.03.03	Tested per ASTM D1752 Type I	Certification with copy of tests	1 per lot
	707.03.04	AASHTO M213		
	707.03.05	Inert, preformed, closed cell, polypropylene material		
Backer Rod	707.03.03	Non-absorbent expanded, closed cell	Certification	1 per lot
	707.03.04	polyethylene		
Bond Breaker Tape	707.03.03	Adhesive strength 35 ounces/in	Certification with copy of tests	1 per lot
	707.03.04	width		
	707.03.05	Tensile Strength 20 lb/in width Thickness 14 mil minimum		
Rubber Gaskets	707.03.06	AASHTO M198		
Waterstops Natural and Rubber	707.03.07	ASTM D412 ASTM D572		

Waterstops Polyvinyl Chloride	707.03.07	ASTM D2240 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

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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.

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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	NO REF	Section 713		
Aggregates Coarse and Fine	NO REF	AASHTO M6 and AASHTO M80	Sieve Analysis	1 per day for QA of External Source
Concrete	NO REF	Section 501	Design submittal	1 per new design and renewal each year
	NO REF	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	NO REF except test pressure in 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 tested.

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.

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/ASTM 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/ASTM standards; ASTM F894		

Table 4 - Plastic PE Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Components				
Pipe Raw Material	NO REF	ASTM D1505 ASTM D1238 ASTM F2136 AASHTO M294	Resin Test, Density, Melt Index, SP-CLS Test, ESCR Test 32-hour	1 per lot
Gasket	NO REF	Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	
Pipe	NO REF	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	NO REF	ASTM D3212	Joint Hydrostatic Test	1 per setup or change
		AASHTO M294	Joint Shear Test	
Inspection	NO REF	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	709.03.10.1.4	Applicable AASHTO/ASTM standards; AASHTO M304; ASTM F949, Section 10.E	Basis of manufactured lot acceptance	See Components below
Solid Wall PVC Pipe	709.03.10.1.6	Applicable AASHTO/ASTM standards; ASTM D3034, SDR 35, or ASTM F679		
Components				
Pipe Raw Material	NO REF	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	NO REF	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	NO REF	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	NO REF	ASTM D3212	Joint Hydrostatic Test	1 per setup or change
		AASHTO M304	Soil Tight Joint	
Inspection	NO REF	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/ASTM standards; AASHTO M264 (ASTM D2680)	Basis of manufactured lot acceptance	See Components below
Components				
Pipe Raw Material	NO REF	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	NO REF	Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	
Pipe	NO REF	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	NO REF	ASTM D3212	Joint Hydrostatic Test	1 per setup or change
Inspection	NO REF	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	NO REF	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)	NO REF	AASHTO M197 AASHTO M218 AASHTO M274	Thickness	Each coil
Corrugation	NO REF	AASHTO M36, Section 7.2	Profile	Each setup
Band MTLs	NO REF	AASHTO M36 Section 9	Thickness and Width	
Lock Seam	NO REF	AASHTO T249	Inspection and Tensile Test	Each day

Table 7 - Metal Pipe				
Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe Coating	NO REF	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	NO REF	AASHTO M218 ASTM A924	Thickness, Diameter (Corrugated Metal Pipe and Pipe Arches including Bituminous Coated)	Each piece
Pipe Inspection	NO REF	AASHTO M36 Section 8.1.1	Dimensions	Each setup per shift
	NO REF	AASHTO M36 Section 9 AASHTO M196 Section 10.1	Workmanship	Each piece
Pressure Pipe Joint	NO REF	ASTM D3212	Hydrostatic Test	1 per setup or change

SECTION 710
STRUCTURAL AND EYEBAR STEEL

SCOPE

710.01.01 MATERIAL COVERED

- A. This specification covers the quality of structural and eyebar steel used in highway structures.

REQUIREMENTS

710.02.01 DEFECTS

- A. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects.
- B. Material shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.
- C. Material shall be free from loose mill scale, rust pits, and other defects affecting its strength or durability.
- D. The Engineer may reject material that Engineer deems unsuitable for the purpose intended even though the material meets the mill tolerances.

710.02.02 CHARPY V-NOTCH TEST

- A. All steel used in and designated as main load carrying members subject to tensile stress shall comply with all the requirements specified for Charpy V-notch test in the various AASHTO standards for the steel involved.
- B. Sampling and testing procedures shall be in accordance with the applicable AASHTO standards.

PHYSICAL PROPERTIES AND TESTS

710.03.01 STANDARD STEEL

- A. This steel shall conform to AASHTO M270 Grade 36.

710.03.02 HIGH STRENGTH-LOW ALLOY STRUCTURAL MANGANESE VANADIUM STEEL

- A. This steel shall conform to AASHTO M270 Grade 50.

710.03.03 HIGH TENSILE STRENGTH BOLTS

- A. This steel shall conform to ASTM A325.

710.03.04 STAINLESS STEEL BOLTS

- A. This steel shall conform to ASTM A276.

710.03.05 WELDED SEAMLESS STEEL PIPE

- A. This steel shall conform to ASTM A53, Grade B.

710.03.06 COLD-FORMED WELDED AND SEAMLESS CARBON STEEL STRUCTURAL TUBING IN ROUNDS AND SHAPES

- A. This steel shall conform to ASTM A500, Grade B, except the minimum tensile strength shall be 55,000 psi.

710.03.07 SHEAR STUD CONNECTORS

- A. This steel shall conform to ASTM A108, Grade 1015 or Grade 1020.
- B. Flux-retaining caps shall be low carbon grade suitable for welding and shall conform to ASTM A109.

710.03.08 PINS AND ROLLERS

- A. Pins or rollers 9 inches or less in diameter shall be forged and heat treated cold finished carbon-steel shafting.
- B. Pins or rollers more than 9 inches in diameter shall be forged and heat treated in accordance with ASTM A235.

SECTION 711
ALUMINUM FOR BRIDGE RAIL
SCOPE

711.01.01 MATERIAL COVERED

- A. This specification covers the quality of aluminum alloy used in bridge rail.

REQUIREMENTS

711.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

711.03.01 ALUMINUM ALLOY FOR PIPE

- A. This pipe shall conform to ASTM B241, Alloy 6061-T6 or Alloy 6063-T6.

711.03.02 ALUMINUM ALLOY TUBING

- A. This tubing shall conform to ASTM B221, Alloy 6061-T6 or Alloy 6063-T6.

711.03.03 CAST ALUMINUM ALLOY

- A. This alloy shall conform to AASHTO M193, Alloy A344-T4.

711.03.04 ALUMINUM ALLOY SHIMS

- A. This alloy shall conform to ASTM B209, Alloy 1100-0.

SECTION 712
MISCELLANEOUS METAL
SCOPE

712.01.01 MATERIAL COVERED

- A. This specification covers the type and quality of miscellaneous metals used on various construction projects.

REQUIREMENTS

712.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

712.03.01 STEEL CASTINGS

- A. This steel shall conform to ASTM A27, Grade 65-35.

712.03.02 GRAY IRON CASTINGS

- A. These castings shall conform to ASTM A48, Class 30.

712.03.03 MALLEABLE CASTINGS

- A. These castings shall conform to ASTM A47, Grade 32510.

712.03.04 WROUGHT IRON PLATES

- A. These plates shall conform to ASTM A42.

712.03.05 BRONZE CASTINGS

- A. These castings shall conform to ASTM B22, Copper Alloy No. 863.

712.03.06 WELDING MATERIALS

- A. Materials used for welding shall conform to the current Specifications for Welded Highway and Railway Bridges of the American Welding Society and current AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

712.03.07 STEEL PILES

- A. This steel ("H" piles and sheet piling) shall conform to ASTM A36.

712.03.08 STEEL SHELL FOR PILES

- A. This steel shall conform to ASTM A252, Grade 2.

SECTION 713
REINFORCEMENT
SCOPE

713.01.01 MATERIALS COVERED

- A. This specification covers the quality of bar steel, fabricated reinforcement, and welded steel wire used in the reinforcement of concrete.

REQUIREMENTS**713.02.01 BLANK****PHYSICAL PROPERTIES AND TESTS****713.03.01 BAR STEEL REINFORCEMENT**

- A. This steel shall conform to the applicable following requirements.

Test	Test Method	Requirements
Deformed Billet-Steel Bars for Concrete Reinforcement	ASTM A615	Grade 40, 60
Axle-Steel Deformed Bars for Concrete Reinforcement	ASTM A996	Grade 40, 60
Spiral Reinforcement	ASTM A615	Grade 60

713.03.02 FABRICATED STEEL BAR OR ROD MATS REINFORCEMENT

- A. This steel shall conform to ASTM A184.

713.03.03 WELDED STEEL WIRE FABRIC REINFORCEMENT

- A. This steel shall conform to ASTM A185.

713.03.04 PRESTRESSING STEEL

- A. Prestressing reinforcement shall be high tensile strength steel wire, high-tensile strength 7-strand wire, or high tensile strength alloy bars as called for on the plans or in the Special Provisions.
- B. High-tensile strength steel wire shall conform to ASTM A421, except that steel may be made by the basic oxygen process.
- C. High-tensile strength 7-strand wire shall conform to ASTM A416, Grade 270.
- D. High-tensile-strength alloy bars shall be stress relieved and then cold stretched to a minimum of 130,000 psi. After cold stretching, the physical properties shall be as follows:

Minimum Ultimate Tensile Strength	145,000 psi
Minimum Yield Strength, Measured by the 0.7 Percent Extension, Under Load Method Shall Be Not Less Than	130,000 psi
Minimum Modulus of Elasticity	25,000,000 psi
Minimum Elongation in 20-bar Diameters After Rupture	4 percent
Diameter Tolerance	+0.03 inch, -0.01 inch

- E. Testing Prestressing Reinforcement and Anchorages:
1. All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes.
 2. Anchorage assemblies to be shipped shall be likewise identified.
- F. All samples submitted shall be representative of the lot to be furnished, and, in the case of wire or strand, shall be taken from the same master roll.
- G. All of the materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.
- H. The Contractor shall furnish for testing the following samples selected from each lot. If ordered by the Engineer, the selection of samples shall be made at the manufacturer's plant by the inspector.
1. **Pretensioning Method.**
 - a. For pretensioned strands, samples at least 5 feet long shall be furnished of each strand size.
 - b. A sample shall be taken from each end of every coil.
 2. **Post-Tensioning Method.** The following lengths shall be furnished:
 - a. For wires requiring heading: 5 feet.
 - b. For wires not requiring heading: sufficient length to make up 1 parallel-lay cable 5 feet long consisting of the same number of wires as the cable to be furnished.
 - c. For strand to be furnished with fittings: 5 feet between near ends of fittings.
 - d. For bars to be furnished with threaded ends and nuts: 5 feet between threads at ends.
 3. **Anchorage Assemblies.** 2 anchorage assemblies shall be furnished, complete with distribution plates of each size or type to be used if anchorage assemblies are not attached to reinforcement samples.

713.03.05 COLD-DRAWN STEEL WIRE FOR SPIRAL REINFORCEMENT

- A. This steel shall conform to ASTM A82.

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 (mcd/ft²/fc).

Entrance Angle	86.0°	86.5°	88.8°
Observance Angle	0.2°	1.0°	1.05°
R_L (mcd/ft²/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/ft²/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 715**GALVANIZING****SCOPE****715.01.01 MATERIALS COVERED**

- A. This specification covers the quality and thickness of galvanizing used on various material when called for on the plans or designed in the specifications.

REQUIREMENTS**715.02.01 BLANK****PHYSICAL PROPERTIES AND TESTS****715.03.01 PRODUCTS 1/8-INCH THICK AND THICKER**

- A. Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to ASTM A123.

715.03.02 GUARDRAIL ELEMENTS

- A. All rail elements shall be galvanized in accordance with AASHTO M180, Type 2.

715.03.03 HARDWARE

- A. Bolts, nut, washers, and fastenings shall be galvanized in accordance with ASTM A153.

SECTION 716
SIGN MATERIALS
SCOPE

716.01.01 MATERIALS COVERED

- A. This specification covers the kind and quality of materials used in the construction and fabrication of traffic control devices used in temporary event zones and for permanent installations.

REQUIREMENTS**716.02.01 GENERAL**

- A. The following materials shall conform to the requirements as noted:

Material	Section
Portland Cement Concrete	501
Reinforcing Steel	505

716.02.02 CERTIFICATES

- A. The Contractor shall ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency.
- B. 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.

716.02.03 SUBMITTALS

- A. Before fabrication is started, 5 sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

PHYSICAL PROPERTIES AND TESTS**716.03.01 REFLECTIVE SHEETING**

- A. Sheeting shall be of the following class sets, as specified in the plans or the proposal, and, unless otherwise specified or approved by the Engineer, shall be Class 6.
- B. The sheeting shall be a material approved by the Engineer, applied to approved sign substrate in accordance with manufacturer's instructions, and conform to the applicable requirements below.
- C. **Class 1 - Non-Retroreflective Plastic Film (ScotchCal or equal):**
1. Pressure sensitive adhesive coated plastic film for sign copy and borders shall be a material recommended by the retroreflective sheeting manufacturer as compatible with the background retroreflective sheeting.
 2. Film shall meet the requirements for Type I, Class 1 of MIL-M-43719B, "Marking Materials and Markers, Adhesive, Elastomeric, Pigmented."
 3. **Life:** Shall be the same as material applied upon.

- D. **Class 2 - Enclosed Lens Retroreflective Sheeting (Engineer grade or equal):**
1. Class 2 sheeting shall meet the requirements of ASTM D4956, Type I.
 2. **Life:** 7 years.
- E. **Class 3 - Enclosed Lens Retroreflective Sheeting (Super Engineering grade or equal):**
1. Class 3 sheeting shall meet the requirements of ASTM D4956, Type II.
 2. **Life:** 10 years.
- F. **Class 4 - Encapsulated Lens Retroreflective Sheeting (High Intensity grade or equal):**
1. Class 4 sheeting shall meet the requirements of ASTM D4956, Type III and/or Type IV.
 2. **Life:**
 - a. 10 years.
 - b. 3 years for Work Zone retroreflective sheeting.
 3. Retroreflective sheeting for work/special event zone reboundable devices (cones and delineators) shall be Class 4 sheeting.
- G. **Class 5 - Wide-Angle Prismatic Retroreflective Sheeting:**
1. Class 5 sheeting shall meet the requirements of ASTM D4956, Type VII sheeting and shall have minimum coefficients of retroreflection, in units of candelas per footcandle per square foot, not less than the values shown below:
 2. **Life:**
 - a. 10 years for fluorescent sheeting.
 - b. 12 years for non-fluorescent sheeting.
 - c. 3 years for fluorescent orange sheeting.
 3. Class 5 fluorescent orange sheeting shall be used on all construction warning signs and devices except Type I, Type II, and Type III barricades.
 - a. Type I, Type II, and Type III barricades shall use non-fluorescent Class 5 sheeting.
 - b. Legends and borders for signs using Class 5 fluorescent orange retroreflective sheeting shall be in accordance with manufacturer's recommendations.
 - c. Retroreflective sheeting for work/special event zone reboundable devices (traffic barrels/drums) shall be Class 5 sheeting.
- H. **Class 6 - Wide-Angle Prismatic Retroreflective Sheeting.**
1. Class 6 sheeting is a wide-angle retroreflective sheeting with optimized performance over a broad range of observation angles and shall meet the requirements of ASTM D4956, Type IX sheeting.
 2. **Life:**
 - a. 10 years for fluorescent sheeting.
 - b. 12 years for non-fluorescent sheeting.
 - c. 3 years for fluorescent orange sheeting.

- I. Fluorescent yellow-green reflective sheeting shall be used on the following signs only:
 - 1. School Advance (S1-1).
 - 2. School Bus Stop Ahead (S3-1).
 - 3. School Speed Limit (S5-1).
 - 4. Advance Pedestrian Crossing (W11-2).
 - 5. Bicycle Crossing (W11-1).
 - 6. Related supplemental plates.
- J. Inks and films for legends and borders on retroreflective sheeting shall be in accordance with manufacturer's specification.
- K. **Field Performance Life Requirement:**
 - 1. The supplier shall warranty that signs supplied shall have an effective retroreflective life of not less than that specified above.
 - 2. The retroreflective sheeting shall be considered unsatisfactory and failing this life requirement if it has deteriorated due to natural causes to the extent that 1 or more of the following is true:
 - a. The sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night conditions.
 - b. The values for the coefficients of retroreflection for Class 2 through Class 6 are less than 50 percent of the required values for the same sign when new.
 - c. The sign material's integrity or adhesion to the sign substrate has substantially failed.
 - 3. Sheeting which fails the life requirement within the specified required lifetime shall be replaced at no charge.
 - 4. Replaced sheeting lifetime shall begin at time of replacement and lifetime shall be to the life requirement per sheeting type.
 - 5. All finished signs shall be dated with the month and year of delivery in order to ascertain compliance with the life requirements.

716.03.02 BLANK

716.03.03 ALUMINUM SIGN PANELS (FOR REFLECTIVE SHEETING)

- A. Sheet aluminum for sign panels shall be of 0.100-inch aluminum alloy Alclad 5052-H38 or 6061-T6 and shall conform to ASTM B209.
- B. Sign panels for street name signs shall be as required in the Standard Drawings.
- C. Sign panel sections shall be fabricated of standard width aluminum sheets not less than 4 feet wide, except that not more than 2 sheets for any 1 sign may be cut not less than 18 inches in width to provide sign widths to nearest 6-inch increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.
- D. The aluminum shall be free of all corrosion, white rust, and dirt.
 - 1. All sign dimensions, metal gauge, and bolt holes shall conform to the plans and these specifications.

2. Blanks shall be cleaned, degreased, and chromated or otherwise properly prepared according to methods recommended by the sheeting manufacturer.
- E. Metal shall not be handled, except by device or clean canvas gloves, between all cleaning operations and the applications of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to application of the background material.
- F. All fabrication, including cutting, shall be completed prior to the cleaning process.
1. Metal panels shall be cut to size and shape and shall be free of defects resulting from fabrication.
 2. The surface of all sign panels shall be a plane surface.

716.03.04 BLANK

716.03.05 OVERHEAD SIGN STRUCTURES AND SIGN FRAMES

- A. The materials used in the fabrication of overhead sign structures and footings shall conform to the requirements specified below.
- B. **Sign Frames:** Bars, plates, and shapes shall be structural steel conforming to ASTM A36.
- C. **Sign Pipe Posts:**
1. Pipe posts shall be welded or seamless steel pipe conforming to ASTM A53, Grade B.
 2. At the option of the Contractor, posts may be fabricated from structural steel conforming to ASTM A36 or ASTM A283, Grade D, except that plates more than 1 inch in thickness shall be structural steel conforming to ASTM A373.
- D. **Sign Steel Walkway Gratings:** Steel walkway gratings shall be furnished and installed in accordance with details shown on the plans and the following provisions:
1. Gratings shall be the standard product of an established grating manufacturer.
 2. Material for gratings shall be structural steel conforming to ASTM A36.
 3. For welded type gratings, each joint shall be full resistance welded under pressure to provide a sound, completely beaded joint.
 4. For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved by the Engineer, and the fabricated grating shall be equal in strength to the welded type.
 5. After fabrication, gratings shall be hot-dip galvanized.
 6. Gratings shall be free from warps, twists, and other defects affecting their appearance or serviceability.
 - a. The tops of the bearing bars and cross members shall be in the same plane.
 - b. Gratings distorted by the galvanizing process shall be straightened.
- E. **Bolts and Nuts:**
1. Bolts and nuts shall conform to ASTM A307.
 2. Bolted connections shall conform to Subsection 506.03.10, "Bolts and Bolted Connections."

- F. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication.
 - 1. Steel shall conform to ASTM A36.
 - 2. Galvanizing shall conform to ASTM A123.
 - 3. All welding shall conform to Subsection 506.03.20, "Welding."
- G. Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section 710, "Structural and Eyebar Steel," and shall be galvanized in accordance with ASTM A153 or cadmium plated in accordance with ASTM A165, Type TS.
 - 1. The top portion of anchor bolts shall be galvanized or cadmium plated so that the galvanized or cadmium plated portion will extend at least 2 inches into concrete.
 - 2. Anchor bolts shall be of the size, shape, and length shown on the plans.
- H. All bolts, nuts, clamps, and metal washers not otherwise noted shall be galvanized or cadmium plated.
 - 1. Cadmium plating shall conform to ASTM A165, minimum thickness as prescribed for grade Type TS.
 - 2. Galvanizing shall conform to ASTM A153.
- I. Supporting frame shall be manufactured in accordance with the plans and requirements herein specified.
 - 1. All metal parts shall be galvanized after fabrication, in accordance with Section 715, "Galvanizing."
 - 2. When permission is granted by the Engineer to zinc coat a surface by means other than hot-dip galvanizing, the metalizing process shall be used to place the zinc.
 - 3. Metalizing shall be performed in accordance with AWS specifications and the thickness of the sprayed zinc coat shall be at least 5 mils.
- J. Truss frames shall be fabricated to the largest practical sections prior to galvanizing.
 - 1. Splice locations shall be submitted to the Engineer for approval.
 - 2. Contractor shall not commence fabrication until such splice locations are approved.
- K. All welding on the fabrication of the structure shall be done by welders qualified in accordance with AWS requirements using the inert-gas shielded-arc method.
 - 1. Welds shall be free from cracks, blow holes, and other irregularities.
 - 2. Welds shall be wire brushed or otherwise cleaned.
 - 3. No field welding on any part of the structural assembly will be permitted.

716.03.06 SIGN HARDWARE, POST, AND RELATED MATERIALS

- A. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication.
 - 1. Steel shall conform to ASTM A36.
 - 2. Galvanizing shall conform to ASTM A123.
 - 3. All welding shall conform to Subsection 506.03.20, "Welding."

- B. Structural I-beam steel shall be galvanized in accordance with ASTM A153 or cadmium plated in accordance with ASTM A165, Type TS.
- C. Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section 710, "Structural and Eyebar Steel."
 - 1. The top portion of anchor bolts shall be galvanized or cadmium plated so that the galvanized or cadmium plated portion will extend at least 2 inches into the concrete.
 - 2. Anchor bolts shall be of the size, shape, and length shown on the plans.
- D. Steel pipe for posts shall conform to ASTM A53, Grade B, and shall be galvanized.
 - 1. Galvanized steel pipe posts shall be of the diameter and length shown on the plans.
 - 2. The top of the posts shall be fitted with a cover.
 - 3. Posts showing damage shall be repaired or rejected.
- E. Wood posts shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress-rated wood material, at the option of the Contractor.
 - 1. The wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and graded in accordance with the provisions contained in Section 718, "Timber."
 - 2. Sweep shall not exceed 0.08 feet in 10 feet.
- F. Aluminum stiffeners, braces, and stringers used as horizontal supporting structural members shall be of aluminum alloy 6061-T6.
 - 1. These extrusions shall have a continuous, inverted "T" slot.
 - 2. The inverted "T" shall accommodate positionable stainless steel clamping devices.
 - 3. The clamping devices shall provide complete freedom of alignment within the slot, forming an interlocking clamp system for fastening the sign to the post.
 - 4. The sign support system described herein shall conform to AASHTO *Standard Specifications for Highway Signs, Luminaires and Traffic Signals*, latest revision, and be rated for minimum wind velocities of 80 mph.
 - 5. All bolts, nuts, clamps, and metal washers in contact with this aluminum channel shall be Stainless Steel Type 304.
 - 6. The system shall be compatible with all I-beam, steel post, and wood post systems.
- G. All other bolts, nuts, clamps, and metal washers in contact with other aluminum components shall be galvanized or cadmium plated.
 - 1. Cadmium plating shall conform to ASTM A165, minimum thickness as prescribed for grade Type TS.
 - 2. Galvanizing shall conform to ASTM A153.
- H. Cantilever arm brackets shall be used when it is desired to offset the entire length of a sign to 1 side of a post or pole.
 - 1. Cantilever arm brackets shall consist of a stainless steel or aluminum head mounted to an extruded aluminum "TEE" section.
 - 2. The "TEE" section shall have a continuous slot that will accept signs up to 1/8 inch thick.

3. If sign thickness, including aluminum sign panel and reflective sheeting, exceeds the width of the "TEE" section slot, sign panel thickness may be reduced to not less than 0.080 inch, or reflective sheeting may be eliminated in the bracket area, as directed by the Engineer.
4. The heads shall be designed to accept 3/4-inch stainless steel banding.
5. The "TEE"-shaped extrusions shall be made from 6061-T6 aluminum alloy.
6. The cantilever arm brackets shall be used to support the entire length of the sign on both the top and the bottom.
7. The sign shall be attached to the brackets using 1/8-inch rivets spaced according to the hole pattern pre-drilled on the extruded "TEE" section.
8. The cantilever arm brackets shall be compatible with any size and shape of post or pole.
9. The system shall be designed for use on signs up to 72 inches in length with a maximum surface area of 9.5 square feet.
10. Signs with surface area greater than 2 square feet shall be fastened to round posts or poles using 3/4-inch by 0.030-inch stainless steel banding.
11. When mounting to square posts or flat surfaces, compatible stainless steel threaded studs or bolts can be used as well as 3/4-inch by 0.030-inch stainless steel banding.
12. For signs less than 2 square feet in surface area, 5/8-inch banding is acceptable.

SECTION 717**TIMBER PILES****SCOPE****717.01.01 MATERIALS COVERED**

- A. This specification covers the quality of round timber piles.

REQUIREMENTS**717.02.01 CERTIFICATES**

- A. Inspection certificates shall be furnished without extra charge with each shipment of timber piles.
- B. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.
- C. Timber piles to be treated shall be inspected prior to treatment by an inspector designated by the Engineer.
1. The inspector shall stamp each pile on the butt end with a stamp that shall make an impression that is readily legible after treatment.
 2. The stamp shall be copyrighted and a true impression filed with the Contracting Agency.

PHYSICAL PROPERTIES AND TESTS**717.03.01 GENERAL**

- A. Timber piles shall conform to ASTM D25.

SECTION 718**TIMBER****SCOPE****718.01.01 MATERIALS COVERED**

- A. This specification covers the quality requirements for structural timber, lumber, guardrail posts, markers, and miscellaneous items.

REQUIREMENTS**718.02.01 GRADES**

- A. Grades furnished shall be as noted on the plans or in the Special Provisions.

718.02.02 CERTIFICATES OF INSPECTION

- A. Inspection certificates shall be furnished without extra charge with each shipment of timber.
- B. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

PHYSICAL PROPERTIES AND TESTS**718.03.01 SPECIES**

- A. The standard commercial and botanical names recognized by these specifications are described as follows:

Standard Commercial Name	Botanical Name
Cedar, Port Orford	<i>Chamaecyparis lawsoniana</i>
Fir, Douglas (coast)	<i>Pseudotsuga taxifolia</i> (coast type)
Fir, Douglas (inland)	<i>Pseudotsuga taxifolia</i> (inter-mountain type)
Hemlock, West Coast	<i>Tsuga heterophylla</i>
Larch	<i>Larix Occidentalis</i>
Redwood, California	<i>Sequoia sempervirens</i>

718.03.02 GRADES

- A. Structural timber and lumber shall meet the requirements for the numerical stress shown on the plans, or as may be otherwise specified, when graded by rules developed in accordance with AASHTO M168.
- B. Any commercial grading rules, including grading rules of The West Coast Lumber Inspection Bureau and the Western Wood Products Association, that will provide material of an equal or greater stress value may be used.
- C. Grading rules in effect on the date of advertisement of bids shall govern.
- D. Guardrail posts and blocks shall meet the following requirements:

1. Douglas Fir and Western Larch shall conform to the West Coast Lumber Inspection Bureau grading rules, paragraph 131-b, No. 1 Structural grade, or with the Western Wood Products Association grading rules, paragraph 80.11.
2. West Coast Hemlock shall conform to the West Coast Lumber Inspection Bureau grading rules, paragraph 131-a, Select Structural grade, or with the Western Wood Products Association grading rules, paragraph 80.10.

SECTION 719**TIMBER PRESERVATIVES****SCOPE****719.01.01 MATERIALS COVERED**

- A. This specification covers the type and quality of materials used in the preservative treatment of timber.

REQUIREMENTS**719.02.01 BLANK****PHYSICAL PROPERTIES AND TESTS****719.03.01 PRESERVATIVES**

- A. Timber preservatives shall conform to AASHTO M133.

SECTION 720
GUARDRAIL MATERIALS

SCOPE

720.01.01 MATERIALS COVERED

- A. This specification covers the quality and kind of material used in the construction of guardrail.

REQUIREMENTS

720.02.01 CERTIFICATES

- A. Contractor shall furnish 2 certified copies of mill test reports showing the chemical and physical characteristics from each heat from which metal is used.
- B. Certificates for wood posts shall be furnished in accordance with Subsection 718.02.02, "Certificates of Inspection."
- C. Rail members, bolts, nuts, and other fittings shall be interchangeable with similar parts regardless of source.

PHYSICAL PROPERTIES AND TESTS

720.03.01 RAIL MEMBERS

- A. Rail members shall conform to AASHTO M180 for Class A, Type 2 guardrail.

720.03.02 FITTINGS

- A. All bolts, nuts, washers, and other fittings for beam-type guardrail shall be steel and of a quality adequate to develop the specified strength of rail splices and to provide a post connection withstanding a 5,000-pound side pull in either direction.
- B. All bolts, nuts, and washers shall be 5/8 inch in size.
1. Bolts shall be buttonhead style and nuts shall be hexagonal.
 2. Bolts and nuts tapped oversize shall not exceed 1/32 inch.
 3. Outside dimensions of bolt heads, nuts, and washers shall have the following minimums:
 - a. Bolt Heads: 1-1/4 inches.
 - b. Nuts: 15/16 inch.
 - c. Washers: 1-1/2 inches.
 4. Splice bolts shall be 1-1/4 inches in length.
 5. Post connection bolts shall be of lengths required to fit the post dimensions and extend beyond the tightened nuts thereon within limits of 1/4 inch to 1/2 inch.
 6. Washers 1/8 inch thick shall be provided for use under nuts on all post bolts and under any nut that has a width of less than 1-1/16 inches.
- C. All fittings shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.03 REFLECTOR PLATES

- A. Reflector plates shall be fabricated from 11 gauge steel sheet or 0.148-inch thick aluminum sheet alloy 6061-T6.
- B. Nails for fastening reflector plates to the guardrail post shall be either galvanized metal or aluminum.
- C. Steel reflector plates shall be galvanized.
- D. Reflectorized material for reflector plates shall conform to Subsection 721.03.03, "Reflectors."

720.03.04 CABLE END ANCHOR ASSEMBLIES

- A. Cable end anchor assemblies for metal beam guard railing shall conform to the provisions specified below.
- B. The anchor plate shall be fabricated of steel conforming to ASTM A36.
- C. The anchor rod shall be fabricated of steel conforming to ASTM A575 or ASTM A576, Grade 1020.
 - 1. The eye may be drop forged or formed with a full penetration weld.
 - 2. The eye shall develop 100 percent of the rod strength.
- D. All bolts and nuts shall conform to ASTM A307 and be galvanized in accordance with Section 715, "Galvanizing."
- E. Anchor cable shall be 3/4-inch preformed, 6 x 19, wire strand core or independent wire rope core (IWRC), galvanized, right regular lay, manufactured of improved plow steel with a minimum breaking strength of 21.4 tons. Two certified copies of mill test reports of each manufactured length of cable used shall be furnished to the Engineer.
- F. Thimbles shall be commercial quality, galvanized steel.
- G. Cable clips shall be commercial quality drop forged galvanized steel.
- H. The swaged fitting and stud assembly shall be of AISI C1035 steel and shall be annealed, galvanized, suitable for cold swaging. The swaged fitting and stud assembly shall develop 100 percent of the breaking strength of the cable.
- I. Contractor shall furnish to the Engineer for testing 1 sample of cable as specified above, properly fitted with swaged fitting, right-hand thread stud at both ends, and 3 feet in total length.

SECTION 721**OBJECT MARKERS AND GUIDE POSTS****SCOPE****721.01.01 MATERIALS COVERED**

- A. This specification covers the quality and kind of material used in the construction of object markers and guide posts.

REQUIREMENTS**721.02.01 CERTIFICATES**

- A. At no additional cost to the Contracting Agency, 2 certificates covering each order of material (plates, reflectors, and posts) shall be furnished by the manufacturer, certifying that the product complies with the specifications.
- B. Certificates shall be delivered to the Engineer at the time of, or prior to, delivery of the order.
- C. For steel used in posts, the Contractor shall furnish 2 certified copies of mill test reports showing the chemical and physical characteristics from each heat.

PHYSICAL PROPERTIES AND TESTS**721.03.01 METAL POSTS**

- A. Posts shall be steel conforming to ASTM A570, Grade C.
- B. Metal posts shall be galvanized in accordance with Section 715, "Galvanizing."

721.03.02 TARGET PLATES

- A. **Base Metal:** Base metal for target plates shall be zinc-coated steel sheet or aluminum sheet.
- B. Zinc-Coated Steel Sheet:
 - 1. The zinc-coated steel sheet shall comply with Federal Specification QQ-S-775, Steel Sheet, carbon, zinc-coated Type 1, Classes d and e, except that the zinc-coated surface shall withstand a 180-degree bend on itself at room temperature without flaking the coating.
 - 2. The zinc-coated surface shall be prepared for painting by the application of phosphate coating.
 - 3. Surface preparation shall conform to the following requirements:
 - a. The phosphatizing process shall be accomplished without damaging or removing the galvanized coating from the steel base metal.
 - b. Any evidence of damage or removal of the zinc coating shall be cause for rejection of the entire lot.

- C. Aluminum Sheet:
1. The aluminum shall be prepared for painting with a chemical conversion coating conforming to Federal Specification MIL-C-5541.
 2. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operation.
 3. Contractor shall furnish 2 copies of certified mill tests of the aluminum sheets to the Engineer.
- D. Target plates shall be fabricated from 20 gauge steel sheet or 0.050-inch thick aluminum sheet, alloy 3005-H14.
- E. Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner.
1. Plates shall be cut to size and shape and the holes punched for mounting bolts and reflectors in accordance with the details shown on the plans.
 2. Surfaces and edges of the plates shall be free from defects resulting from fabrication.
- F. **Paint:**
1. Target plates shall have satisfactory paint adherence.
 2. The plates shall be coated with baked enamel conforming to the following provisions:
 - a. The enamel finish coat for plates shall comply in all respects with Federal Specification TT-E-489, Class B baking type enamel, with the added requirement that the yellowness index of the white enamel shall not exceed 0.08 when tested in accordance with Federal Test Method Standard No. 141, Method 6131.
 - b. Application of the baking enamel may be by spray, roller, or dip, at the option of the manufacturer. Other methods may be used provided they are approved prior to use.
 - c. The dry film thickness of the baked enamel coating on the galvanized steel plates shall be not less than 2.0 mils on both front and back surfaces.
 - d. The dry film thickness on both front and back surfaces of the aluminum plates shall be:
 - 1) Not less than 1.5 mils on each side if enamel is applied by spray or dip method.
 - 2) Not less than 1.0 mil if enamel is applied by continuous roller coat method.
 - e. The coating shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, and other surface imperfections.
- G. The finished plates shall be free from dents and defects. The maximum surface deviation from a horizontal plane on which the finished plate lies shall not exceed 0.25 inch.

721.03.03 REFLECTORS

- A. **Photometric Requirements:**
1. Each reflective delineator shall have the following minimum brightness values at 2 degrees divergence expressed as candlepower per foot candle.
 2. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex reflectors of the Society of Automotive Engineers.

Angle of Incidence	Silver-White		Yellow	
	Divergence Angle			
	0.2	0.5	0.2	0.5
	Brightness (cd/ftcd)			
0 degrees	9.0	3.8	5.3	2.3
15 degrees	8.0	3.4	4.4	2.0
30 degrees	5.4	2.9	2.7	1.2
45 degrees	2.6	1.1	1.0	0.5

3. The brightness of the reflective sheeting, totally wet by rain, shall not be less than 90 percent of the above values.
 4. Wet performance measurements shall be conducted in conformance with standard rainfall tests specified in MIL-R-13689A.
- B. **Durability.** The delineator surface shall readily be refurbished by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

SECTION 722**WATER****SCOPE****722.01.01 MATERIAL COVERED**

- A. This specification covers the quality of water from non-potable sources for use in preparing cement concrete or soil-cement mixtures, and for wetting embankment, backfill, subgrade, and gravel base and surfacing courses.

REQUIREMENTS**722.02.01 GENERAL**

- A. All water for embankments, backfill, subgrade, gravel base, landscaping, and surface courses and cement concrete curing shall be free from an excessive amount of acids, alkali, oil, and other substances which, in the opinion of the Engineer, will cause damage to the above mentioned items.

PHYSICAL PROPERTIES AND TESTS**722.02.02 CONCRETE USE**

- A. Samples submitted for tests shall consist of 2 quarts of water, obtained and shipped in clean glass containers carefully packed and labeled.
- B. Tests shall be made in accordance with AASHTO T26.
- C. Any indication of unsoundness, marked change in time of setting, or a reduction of more than 10 percent in strength from results obtained with concrete mixtures containing the water of satisfactory quality shall be sufficient cause for rejection of the water under tests.

SECTION 723**HARDWARE****SCOPE****723.01.01 MATERIALS COVERED**

- A. This specification covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings.

REQUIREMENTS**723.02.01 BLANK****PHYSICAL PROPERTIES AND TESTS****723.03.01 GALVANIZING**

- A. Galvanizing, when required, shall comply with ASTM A153.

723.03.02 BOLTS, NUTS, DOWELS, AND DRIFT BOLTS

- A. Bolts, nuts, dowels, and drift bolts shall conform to ASTM A307, Grade A, unless otherwise specified.

723.03.03 WASHERS

- A. Cast washers shall be of cast iron of the 0-gee type.
1. The diameter shall be not less than 3-1/2 times the diameter of the bolts for which it is used.
 2. The diameter of the hole shall be 1/8 inch larger than the diameter of the bolt.
- B. Flat malleable washers shall be of malleable iron with ribs properly proportioned to develop the full strength of the bolt and, unless otherwise shown on the plans, shall comply with the following:
1. The diameter shall be not less than 3-1/2 times the diameter of the bolt for which it is used.
 2. The thickness shall be equal to 1/2 the diameter of the bolts.
 3. The diameter of the hole shall be 1/8 inch larger than the diameter of the bolt.

SECTION 724
FENCE MATERIALS

SCOPE

724.01.01 MATERIALS COVERED

- A. This specification covers the quality of barbed wire, woven wire, and chain-link fabric fencing, fence posts, gates, and miscellaneous fence hardware.

REQUIREMENTS

724.02.01 SAMPLES AND CERTIFICATES OF INSPECTION

- A. The Contractor shall supply the Engineer with 3 line posts for testing purposes, the posts to be selected at random by the Engineer.
- B. At no additional cost to the Contracting Agency, 2 certificates covering each order of material shall be furnished from the manufacturer, certifying that the various metal components comply with the requirements herein.
- C. The certificates shall be delivered to the Engineer at the time, or prior to, delivery of the order.

PHYSICAL PROPERTIES AND TESTS

724.03.01 WOOD POSTS

- A. Intermediate braced posts and braces shall be of the same type as line posts.
- B. End, gate, and corner post assemblies, including bracing timber, shall be sawed, shall conform to the grading requirements of Section 718, "Timber," and shall be of Douglas Fir, Larch, or Southern Pine.
- C. Line posts and intermediate braced posts and bracing shall be round and shall be of Douglas Fir, Southern Pine, Lodge Pole Pine, or Larch manufactured from sound live trees well seasoned and free from large knots, shakes, or splits or other defects that will impair their strength or durability.
1. The posts and braces shall be peeled to remove all outer bark and all inner cambium bark, except an occasional strip of inner bark may remain if not over 1/2 inch wide or 3 inches long.
 2. All knots shall be trimmed flush with the side, spurs and splinters removed, and ends cut square.
- D. Line posts and intermediate braced posts and braces shall not be less than 7 feet long and all other posts and braces shall be not less than 8 feet long.
- E. The small end of round line posts and braces shall be between 3-1/2 inches and 4-1/2 inches in diameter; the small end of intermediate braced posts shall be between 5-1/2 inches and 6-1/2 inches in diameter. The allowable taper from end to end of round posts and braces shall not exceed 1-1/2 inches.
- F. All posts and braces shall be pressure-treated with creosote, creosote-coal tar solution, or pentachlorophenol solution in accordance with Section 719, "Timber Preservatives."

1. The minimum weight of pentachlorophenol solution retained per cubic foot of post shall be 0.6 pound.
 2. Pentachlorophenol solution shall consist of 5 percent pure pentachlorophenol in light petroleum.
 3. All posts and braces shall be treated with the same type of preservative.
- G. When pressure-treated materials have been damaged or when it has been absolutely necessary to cut or bore into them, after delivery to the job site, all exposed untreated wood shall be carefully field treated with preservative applied either by thorough swabbing or by an approved bolt-hole treater as the Contractor may elect.

724.03.02 METAL POSTS

- A. Tubular posts shall be galvanized standard-weight steel pipe conforming to ASTM F1083, except that the hydrostatic test will not be required.
- B. At the Contractor's option, tubular pipe and posts conforming to AASHTO M181, Grade 2 may be used, except that Grade 2 posts shall be only zinc plus organic coated.
- C. C-section posts and braces shall be roll formed steel conforming to ASTM A570, Grade 45 and zinc coated in accordance with ASTM F1083 or zinc plus organic coated in accordance with AASHTO M181, Grade 2.
1. The required exterior coating shall be applied to both the interior and exterior of C-section posts.
 2. Pre-galvanized C-section posts may be used provided the edges are coated in conformance with ASTM A780.
- D. Pipe and posts shall meet the following performance criteria when subjected to salt spray testing in accordance with ASTM B117:
1. Exterior surface - 1,000 hours with maximum 5 percent red rust.
 2. Interior surface - 650 hours with maximum 5 percent red rust.
- E. The base metal for the manufacturer of other steel sections used for post and braces shall be good commercial quality weldable steels.

POST SIZES FOR CHAIN-LINK FENCE 6-Foot or Less Fabric Height and Type A Fencing		
Post Location	Post Type	Minimum Post Size
Terminal	Pipe	2.375-inch O.D. X 0.130 X 3.12 lbs/ft
		2.375-inch O.D. Schedule 40 X 3.65 lbs/ft
Line	Pipe	1.900-inch O.D. X 0.120 X 2.28 lbs/ft
	C-Section	1.900-inch O.D. Schedule 40 X 2.72 lbs/ft
Temporary Line	T-Post	1.875-inch X 1.625-inch X 1.85 lbs/ft
	C-Section	X 1.13 lbs/ft
Braces	Pipe	1.660-inch O.D. X 0.110 X 1.82 lbs/ft
	C-Section	1.660-inch O.D. Schedule 40 X 2.27 lbs/ft
	C-Section	1.625-inch X 1.250-inch X 1.35 lbs/ft

POST SIZES FOR CHAIN-LINK FENCE 6-Foot or Less Fabric Height and Type A Fencing		
Post Location	Post Type	Minimum Post Size
Gate	Gate Leaf Width Up to 6 feet	2.875-inch O.D. X 0.160 X 4.64 lbs/ft
		2.875-inch O.D. Schedule 40 X 5.79 lbs/ft
	Greater than 6 feet through 13 feet	4.000-inch O.D. X 0.160 X 6.56 lbs/ft
		4.000-inch O.D. Schedule 40 X 9.11 lbs/ft
	Greater than 13 feet through 18 feet	6.625-inch O.D. Schedule 40 X 18.97 lbs/ft
Greater than 18 feet through 23 feet	8.625-inch O.D. Schedule 40 X 28.55 lbs/ft	

POST SIZES FOR CHAIN-LINK FENCE Greater than 6-Foot to 8-Foot Fabric Height		
Post Location	Post Type	Minimum Post Size
Terminal	Pipe	2.875-inch O.D. X 0.160 X 4.64 lbs/ft
		2.875-inch O.D. Schedule 40 X 5.79 lbs/ft
Line	Pipe	2.375-inch O.D. X 0.130 X 3.12 lbs/ft
	C-Section	2.375-inch O.D. Schedule 40 X 3.65 lbs/ft
Braces	Pipe	1.875-inch X 1.625-inch X 2.28 lbs/ft
	C-Section	1.660-inch O.D. X 0.110 X 1.82 lbs/ft
	Pipe	1.660-inch O.D. Schedule 40 X 2.27 lbs/ft
	C-Section	1.625-inch X 1.250-inch X 1.35 lbs/ft

POSTS SIZES FOR CHAIN-LINK FENCE Greater than 8-Foot to 12-Foot Fabric Height		
Post Location	Post Type	Minimum Post Size
Terminal	Pipe	4.00-inch O.D. X 0.160 X 6.56 lbs/ft
		4.00-inch O.D. Schedule 40 X 9.11 lbs/ft
Line	Pipe	2.875-inch O.D. X 0.160 X 4.64 lbs/ft
		2.875-inch O.D. Schedule 40 X 5.79 lbs/ft
Braces	Pipe	1.660-inch O.D. X 0.110 X 1.82 lbs/ft
	C-Section	1.660-inch O.D. Schedule 40 X 2.27 lbs/ft
	C-Section	1.625-inch X 1.250-inch X 1.35 lbs/ft

- F. Gate posts for standard Type A fencing shall be as specified herein for chain-link fence except that for single gates over 13 feet and up to 18 feet, the posts shall be pipe, 4.000 inch O.D. by 0.160 (minimum) weighing not less than 6.56 pounds per linear foot.
- G. T-Section Posts:
 - 1. T-section posts shall be manufactured of steel conforming to ASTM A238, ASTM A663, or ASTM A675, or shall be manufactured to comply with ASTM A702, T-section type.
 - 2. T-section posts shall be manufactured to tolerances and workmanship as provided in ASTM A702.

3. T-section posts shall be provided with tapered anchor plates attached securely thereto.
 - a. The anchor plates shall weigh not less than 0.67 pound and have a minimum area of 15 square inches.
 - b. The top edge of the anchor plate shall be from 16 inches to 24 inches above the bottom end of the line post for Type A and Type C fence.
 - c. The anchor plate may be omitted provided the post is set in concrete.
 - d. Each post shall be furnished with galvanized wire clamps as follows: 1 clamp for each strand of barbed wire; and clamp for the top, bottom, and at not more than 14-inch intervals between top and bottom for mesh fencing.
4. T-section posts shall be galvanized or painted with anti-corrosive paint. The posts shall be drilled, notched, or stubbed to facilitate fastening the fencing.

724.03.03 BARBED WIRE

- A. Barbed wire may be either steel or aluminum alloy.
- B. Steel barbed wire shall conform to ASTM A121. The coating weight shall be Class I unless otherwise specified.
- C. Barbed wire shall be composed of 2 strands of No. 12-1/2 gauge wire with 4-point barbs of 14 gauge spaced not more than 5 inches apart.
- D. Aluminum alloy barbed wire shall be manufactured of aluminum alloy conforming to ASTM B211, alloy 5052-0 for the line wire and alloy 5052-H38 for the barbs.

724.03.04 WOVEN WIRE

- A. Woven wire shall conform to ASTM A116, No. 12-1/2 Farm.

724.03.05 CHAIN-LINK FABRIC

- A. Chain-link fabric and required fittings and hardware shall conform to AASHTO M181. The coating weight shall be 1.2 ounces of zinc per square foot or Type II aluminum coated unless otherwise specified by the Engineer.
- B. The wire used in the manufacture of the fabric shall be 11 gauge for all fence 72 inches or less in height.

724.03.06 STAPLES, BRACE WIRE, AND NAILS

- A. Brace wire shall be 8 gauge, medium temper, 55,000 psi to 75,000 psi tensile strength, and shall be galvanized as specified for barbed wire.
- B. Staples shall be made from No. 9 U.S. gauge galvanized and shall be of the L-shaped (Strong-Hold) type. The long shank shall be threaded 1-3/4 inches.

724.03.07 METAL GATES

- A. **Drive Gates for Standard Fencing.**
 1. The gate frames shall be constructed of not less than 1-inch galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified in ASTM A53. Hydrostatic test will not be required.

2. Galvanized tubular steel braces shall be placed vertically in each gate, and corner and brace joints shall be so secured that the gate will retain a true rectangular shape.
3. The wire mesh shall be rectangular mesh or 2-inch diamond mesh and shall be galvanized as specified for woven wire fabric.

B. Drive Gates for Chain-Link Fencing:

1. The gate frame shall be constructed of not less than 1-1/2-inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under ASTM A53 (hydrostatic test will not be required), or 1-7/8-inch O.D. pipe conforming to AASHTO M181, Grade 2.
2. Gate frames shall be cross-trimmed with galvanized 3/8-inch adjustable truss rods.
3. The corners of the gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose of welding.
4. Chain-link fence fabric as specified for the fence shall be attached to the gate frame by stretcher bars and tie wires as specified for fence construction and suitable tension connectors spaced at approximately 1-foot intervals.

C. Walk Gates:

1. Unless otherwise specified, walk gates shall be 3-1/2 feet wide and of the height corresponding to the adjacent fence.
2. The gate frame shall be constructed of not less than 3/4-inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under ASTM A53. Hydrostatic test will not be required.
3. The gate frame shall be filled with fabric as specified herein.
4. The gate shall be furnished complete with approved hinges, latches, and auxiliary braces as required.

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 D 395, 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 (.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:**

- 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.
- 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/ 100 Grams of Fiber)	1,150 minimum

C. Wood Cellulose Fiber:

- Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors.
- Mulch shall be dyed a suitable color to facilitate inspection of the placement of the material.

D. Wood Chips and Shavings:

- Wood chips and shavings shall be manufactured from any clean wood free of infestations.
- Chips from kiln-dried or air-dried material will not be acceptable.
- Chips shall be produced by machinery equipped with knives or blades which cut rather than shred or break the material.
- 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.

SECTION 727**CONCRETE SURFACE FINISHING MATERIAL****SCOPE****727.01.01 MATERIAL COVERED**

- A. This specification covers the types and quality of concrete surface finishing materials.

PHYSICAL PROPERTIES AND TESTS**727.02.01 REQUIREMENTS**

- A. Bonded grout finishing material shall conform to the provisions specified below.
- B. Except as noted herein, tests shall be made in accordance with test method indicated. Federal standard test methods are as contained in FED-STD-141, most current edition.
- C. Viscosity: 110-115 K.U., using pin paddle. (Federal Standard. Method No. 4281)
- D. Total Solids (Federal Standard Test Method No. 4042):
1. By weight: 65% minimum.
 2. By volume: 48% minimum.
- E. Flexibility (Federal Standard Test Method No. 6221):
1. Pass 1/8-inch mandrel when spread 12 mils wet on a tin panel and air dried 16 hours at 120 degrees F.
 2. Panel shall show no mud cracking and no loss in adhesion to the panel when bent.
- F. Water Resistance: No softening when tested as follows (ASTM D1647):
1. Spread a 12-mil film on tin panel and allow to air dry 48 hours.
 2. Immerse in water for 16 hours and allow to dry for 8 hours.
 3. There shall be no effect on the material.
- G. Weatherometer Durability (Federal Standard Test Method No. 6152):
1. Expose a 12-mil film applied to asbestos cement board for 500 hours in an Atlas Twin-Arc weatherometer.
 2. There shall be no erosion, cracking, softening, or other visible defects in the coating.

SECTION 728**EPOXY****SCOPE****728.01.01 MATERIALS COVERED**

- A. These specifications are intended to specify epoxy that will meet service requirements for street and highway construction.
- B. Epoxy shall be furnished as 2 components that shall be mixed together at the site of the work.

REQUIREMENTS**728.02.01 SAMPLING AND TESTING**

- A. Epoxy shall not be used prior to sampling and testing unless its use is permitted prior to said sampling and testing in accordance with the provisions in Subsection 106.05, "Certificates of Compliance."
- B. All tests will be conducted in accordance with the latest test methods of ASTM International and Federal Test Method Standard No. 141.

728.02.02 CERTIFICATES

- A. Without expense to the Contracting Agency, 2 certificates covering each order of material shall be furnished by the manufacturer, certifying that the product complies with the specifications.
- B. Certificates shall be delivered to the Engineer in charge at the jobsite at the time of, or prior to, delivery of the order.

728.02.03 PACKAGING, LABELING, AND STORING

- A. Each component shall be packaged in steel containers not larger than 5 gallons in volume.
- B. When the components are to be mixed at a ratio of 2 parts Component A to 1 part Component B, by volume, the container containing Component B shall be 1/2 the volume of the container containing Component A.
- C. The containers shall have lug-type crimp lids with ring seals, shall be new, shall be not less than 24 gauge, shall otherwise meet U.S. Department of Transportation Hazardous Materials Shipping Regulations, and shall be well sealed to prevent leakage.
- D. If a lining is used in the containers, it shall be of a character to resist any action by the components.
- E. Each container shall be clearly labeled with the designation (Component A or Component B), manufacturer's name, date of manufacture, batch number (a batch shall consist of a single charge of all components in a mixing chamber), all directions for use specified elsewhere, and the following warning:

CAUTION

This material will cause dermatitis if it is allowed to come in contact with the skin or eyes. Use gloves and protective creams on the hands. Should this material contact the skin, wash thoroughly with soap and water. Do not attempt to remove this material from the skin with solvents. If any gets in the eyes, flush for 10 minutes with water and secure immediate medical attention.

- F. Attention is directed to the characteristics of some epoxy components to crystallize or thicken excessively prior to use when stored at temperatures below 35 degrees F. Any material that shows evidence of crystallization or a permanent increase in viscosity or settling of pigments that cannot be readily redispersed with a paddle shall not be used.

728.02.04 DIRECTIONS FOR USE

- A. At the time of mixing, Component A and Component B shall be at a temperature between 60 degrees F and 85 degrees F, unless otherwise specified.
- B. Any heating of the adhesive components shall be done by application of indirect heat.
- C. Immediately prior to mixing, each component shall be thoroughly mixed with a paddle. Separate paddles shall be used to stir each component.
- D. Immediately prior to use, the 2 components shall be thoroughly mixed together in the specified ratios.
1. When mixed, all adhesive, except coal tar modified epoxy, shall have a uniform gray color without black or white streaks.
 2. No solvent shall be added to any epoxy.
- E. After mixing, all epoxies shall be placed in the work and any overlaying or inserted material that is to be bonded to the work by the epoxy shall also be placed before thickening of the epoxy has begun.
- F. Surfaces upon which epoxy is to be placed shall be free of rust, paint, grease, asphalt, and loose and deleterious material.
- G. When epoxy is used as a binder to make epoxy concrete or mortar, the 2 components of epoxy shall be thoroughly mixed together before the aggregate is added and, unless otherwise specified, the mix proportions shall consist of 1 part binder to approximately 4 parts aggregate, by volume.
- H. Aggregate for use in epoxy concrete and mortar shall be clean and shall have a moisture content of not more than 0.50 percent when tested in accordance with ASTM D2216.
- I. All surfaces against which epoxy concrete and mortar are to be placed shall be primed with a coat of the epoxy used just prior to placing the mortar.

PHYSICAL PROPERTIES AND TESTS**728.03.01 BINDER (ADHESIVE), EPOXY RESIN BASE****A. Classification:**

1. This specification covers a low viscosity, liquid polysulfide extended epoxy formulated primarily for use in making high-strength epoxy concrete and epoxy mortar, in fastening metal anchors in vertical holes in concrete, and in pressure grouting of cracks in concrete.

2. Thick sections of this epoxy are not suitable for use in freeze-thaw environments.
3. Epoxy Resin Base Binder (Adhesive) shall conform to AASHTO M235 or ASTM C881.

B. Directions for use:

1. The ingredients in Component A and Component B shall be thoroughly dispersed such that each component forms a fluid mixture.
2. The mixing ratio is 2 parts by volume of Component A to 1 part by volume of Component B.
3. No more material shall be mixed than can be used within 10 minutes from the time mixing operations are started.

728.03.02 COAL TAR MODIFIED EPOXY RESIN

A. Classification:

1. This specification covers a low viscosity, liquid coal tar extended epoxy formulated primarily for use with a cover of aggregate as a black seal and skid resistant surfacing for Portland cement concrete and for use in making low strength epoxy concrete and epoxy mortar.
2. This epoxy is suitable for use in freeze-thaw environments.
3. Coal Tar Modified Epoxy Resin shall conform to ASTM C881.

B. Directions for use:

1. Equal parts, by weight or volume, of Component A and Component B shall be mechanically batch mixed, or continuously mixed in automatic paving equipment that provides continuous metering, mixing, and application at a controlled rate.
2. If the components are to be batch mixed, mixing shall be performed with a propeller type stirrer, or other power driven agitator attached to a 1/2 inch heavy duty drill.
3. Care shall be exercised to thoroughly incorporate material at the sides and bottom of the mixing container.
4. When mixed in batches, the mixing time shall be 5 minutes at 60 degrees F to 80 degrees F or 3 minutes at 80 degrees F to 100 degrees F and the batch size shall not exceed 5 gallons.
5. The mixed material will set quickly if allowed to remain in large mass, due to the heat generated as the 2 components react.
6. Pot life in large quantities (1 gallon to 5 gallons) is approximately:

Material Temperature	Pot Life (Measured from Beginning of Mixing)
60-70 degrees F	18 minutes
70-80 degrees F	12 minutes
80-90 degrees F	10 minutes
90-100 degrees F	8 minutes

728.03.03 EPOXY RESIN ADHESIVE FOR BONDING NEW CONCRETE TO OLD CONCRETE**A. Classification:**

1. This specification covers a low viscosity paste polysulfide extended epoxy formulated primarily for use in bonding new Portland cement concrete to old Portland cement concrete and in fastening metal anchors in horizontal holes in concrete.
2. This epoxy is available in 2 types:
 - a. Type I for general use.
 - b. Type II for use when cure temperatures are below 60 degrees F, or when a faster cure is required.
3. Thick sections of this epoxy are not suitable for use in freeze-thaw environments.
4. Epoxy Resin Adhesive shall conform to AASHTO M235 or ASTM C881.

B. Directions for use:

1. The ingredients in Component A and Component B shall be thoroughly agitated so each component forms a uniform paste.
2. The mixing ratio is 2 parts by volume of Component A to 1 part by volume of Component B.
3. When measuring individual Component A and Component B, stir and tap the measuring containers to remove possible air voids.
4. Do not mix more material than can be spread within 8 minutes from the time mixing operations are started.
5. The spreading rate shall be sufficient to thoroughly coat the surface.
6. Spread the mixed adhesive by brush or roller over thoroughly cleaned concrete at a rate not exceeding 40 square feet per gallon.
7. On very rough surfaces, the spreading rate shall be 25 square feet per gallon.
8. The new concrete shall be placed against the adhesive coating on the old concrete within 15 minutes after spreading at temperatures below 90 degrees F or within 10 minutes at temperatures above 90 degrees F.

728.03.04 BLANK**728.03.05 BLANK****728.03.06 BINDER (ADHESIVE), EPOXY RESIN BASE, ALKYL BENZENE EXTENDED****A. Classification:**

1. This specification covers a medium viscosity, liquid alkylbenzene extended epoxy formulated primarily for use with aggregate as a gray seal and skid-resistant surfacing for Portland cement concrete and for preparing low-strength epoxy mortar and epoxy concrete.
2. This epoxy is suitable for use in freeze-thaw environments.

3. Alkylbenzene Extended Epoxy Resin Base Binder (Adhesive) shall conform to ASTM C881.

B. Directions for use:

1. The mixing ratio is 1 part by volume of Component A to 1 part by volume of Component B.
2. No more material shall be mixed than can be used within 10 minutes from the time mixing operations are started.

728.03.07 BINDER (ADHESIVE), EPOXY RESIN BASE, FAST SETTING

A. Classification:

1. This specification covers a medium viscosity, liquid rapid set epoxy formulated primarily for use in making high-strength epoxy concrete and epoxy mortar where low curing temperatures are expected or when a fast cure is required.
2. This epoxy is not formulated for use in bonding of new Portland cement concrete to old Portland cement concrete.
3. This epoxy is suitable for use in freeze-thaw environments.
4. Fast Setting Epoxy Resin Base Binder (Adhesive) shall conform to ASTM C881.

B. Directions for use:

1. The mixing ratio is 2 parts by volume of Component A to 1 part by volume of Component B.
2. Aggregate shall be added immediately after Component A and Component B are thoroughly mixed.
3. The epoxy mortar or concrete shall be placed as soon as possible.
4. The useful work life of the mortar will depend on temperature, but shall be about 10 minutes to 15 minutes at 75 degrees F.
5. All surfaces shall be primed with mixed epoxy.

728.03.08 BINDER (ADHESIVE), EPOXY RESIN BASE, FAST SETTING, ALKYL BENZENE EXTENDED

A. Classification:

1. This specification covers a medium viscosity, liquid rapid set, alkylbenzene extended epoxy formulated primarily for use with aggregate as a gray seal and as a skid-resistant surfacing for Portland cement concrete and for use in making low-strength epoxy concrete and epoxy mortar where low curing temperatures are expected or when a fast cure is required.
2. This epoxy is suitable for use in freeze-thaw environments.
3. Fast Setting Epoxy Resin Base Alkylbenzene Extended Binder (Adhesive) shall conform to ASTM C881.

B. Directions for use:

1. The mixing ratio is 1 part by volume of Component A to 1 part by volume of Component B.

2. Do not mix more material than can be used within 10 minutes from the time mixing operations are started.
3. When applying resinous seal, the aggregate shall be sprinkled in the epoxy film not later than 5 minutes after epoxy is applied to the road surface.

728.03.09 EPOXY SEALANT FOR INDUCTIVE LOOPS

A. Classification:

1. This specification covers a high viscosity, liquid epoxy formulated primarily for use in sealing inductive wire loops and leads imbedded in asphalt concrete and Portland cement concrete for traffic signal controls and vehicle counters.
2. This epoxy is to be used for repair work on existing spalls, cracks, and other deformations in and around saw cuts and housing inductor loops and leads.
3. The rapid cure allows minimum traffic delay.
4. This sealant is suitable for use in freeze-thaw areas and can be used on grades up to 15 percent without excessive flow of material.
5. Epoxy Sealant for Inductive Loops shall conform to ASTM C881.

B. Directions for use:

1. Saw cuts shall be blown clean and dry with compressed air to remove all excessive moisture and debris.
2. For repairing damaged saw cuts, all loose, spalled material shall be cleaned away from saw cut, chipping back to sound asphalt concrete or Portland cement concrete, and all loose material cleaned from loop wires.
3. The mixing ratio is 1 part by volume of Component A to 1 part by volume of Component B. No more material shall be mixed than can be used within 10 minutes from the time mixing operations are started.

728.03.10 EPOXY ADHESIVES FOR PAVEMENT MARKERS

A. Rapid-Set Epoxy Adhesive:

1. This specification covers a high viscosity, rapid set epoxy formulated primarily for use in bonding pavement markers to Portland cement concrete and asphalt cement.
2. The epoxy used under this specification shall conform to AASHTO M237, Type I.
3. Tests for requirements for AASHTO M237 shall be performed in accordance with AASHTO T237.

B. Standard-Set Epoxy Adhesive:

1. This specification covers a high viscosity, rapid set epoxy formulated primarily for use in bonding pavement markers to Portland cement concrete and asphalt cement.
2. The epoxy used under this specification shall conform to AASHTO M237, Type II.
3. Tests for requirements for AASHTO M237 shall be performed in accordance with AASHTO T237.

728.03.11 BINDER (ADHESIVE), STRUCTURAL EPOXY**A. Classification:**

1. This specification covers a multipurpose, 2-component, moisture tolerant, structural epoxy adhesive, formulated primarily for bonding new concrete to asphalt cement pavement.
2. This epoxy is formulated for hot weather concrete placements requiring a bonding adhesive and is suitable for minimum substrate and ambient temperature of 40 degrees F.
3. Physical properties shall meet the criteria a minimum of 2,200 psi and heat deflection temperature at 14 days shall be a minimum of 108 degrees F.

B. Directions for use:

1. The epoxy shall not be mixed with more material than can be used within 60 minutes at 73 degrees F or 30 minutes at 100 degrees F from the time mixing operations begin.
2. Surface shall be clean and sound.
3. Surface may be dry or damp, but shall be free of standing water, dust, curing compound, and other contaminants.

SECTION 729**FLY ASH****SCOPE****729.01.01 MATERIALS COVERED**

- A. This specification covers the quality of fly ash used in Portland cement products.

REQUIREMENTS**729.02.01 REQUIREMENTS**

- A. Fly ash shall conform to ASTM C618 for Class F, with the following exceptions:
1. The maximum loss of ignition shall be 6 percent.
 2. The sulfate resistance factor, R, shall not exceed 1.5, where

$$R = \frac{(\% \text{ CaO} - 5)}{\% \text{ Fe}_2\text{O}_3}$$

- B. Certification that the fly ash used in Portland cement concrete conforms to ASTM C618 shall be provided by the supplier of the fly ash.
- C. Copies of the certification shall be provided to the Engineer by the supplier of the fly ash or supplier of the Portland cement concrete fly ash upon request.
- D. The certification provided is to be a maximum of 30 days old.

PHYSICAL PROPERTIES AND TESTS**729.03.01 BLANK**