

SECTION 700 - MATERIALS

GENERAL STATEMENT

For all materials used in the work for which there is no specified testing by the project Inspectors or the Laboratory, the Contractor shall submit a Materials Certification Letter similar to the following, prior to acceptance as specified in Section 107.9.4:

Company Letterhead

Mr./Mrs. _____, Resident Date _____

Address _____ Project No. _____

Town _____

This is to certify that all materials incorporated into the project for which there is no specified testing by project inspectors or the laboratory, comply with the pertinent specified material requirements of the contract. Processing, project testing, and inspection control of raw materials are in conformity with the applicable drawings and/or standards of all articles furnished.

All records and documents pertinent to this letter and not submitted herewith will be maintained and will be available by the undersigned for a period of not less than three years from the date of completion of the project.

The Materials Certification letter must be signed by a person having legal authority to bind the Contractor.

Materials listed in the above Certificate may be subject to random sampling and testing by the Department. Certified materials, which fail to meet specification requirement, may not be accepted.

The Contractor may be required to submit to the Resident, for inclusion in the project records, certification and other data from the Manufacturer pertaining to materials used on the project.

For Performance-Graded Binder, the Contractor shall arrange for the Supplier to furnish a Quality-Control Plan and CERTIFICATE OF ANALYSIS for all asphalt materials furnished for use on the project. The Certificate shall include the actual test results of the material in storage from which the shipments are being made. Certificates shall be supplied for each lot, batch, or blend of each type and grade of material. A new certificate shall be issued at least every 30 days or upon receiving or manufacture of a new material. The original of each Certificate of Analysis shall be mailed to the Testing Engineer, Maine Department of Transportation, P.O. Box 1208, Bangor, Maine 04402-1208.

The Contractor shall give the supplier sufficient advance notice of orders to permit testing. Material not represented by tests will not be accepted for use on the work.

Deliveries of asphalt materials shall be accompanied by a loading invoice, delivery ticket, or slip, as required under Section 108.1.3 f. The Loading Invoice shall include the applicable certificate number and shall include a printed or stamped statement such as the following:

“THIS IS TO CERTIFY THAT THE ASPHALT MATERIAL REPRESENTED BY THIS LOADING INVOICE CONFORMS TO THE SPECIFICATIONS OF THE PURCHASER FOR THE MATERIAL TYPE AND GRADE STATED THEREON.”

In the event an intermediate hauler of the asphalt material is involved, a copy of their own delivery slip shall be furnished, as well as a copy of the supplier's loading invoice. The hauler's delivery slip and the supplier's loading invoice shall be cross-referenced by use of their respective serial numbers.

All test procedures shall conform to the requirements of AASHTO unless otherwise noted. Gradation tests shall be completed in accordance with AASHTO T27 except that the sample may be separated on the 12.5 mm [$\frac{1}{2}$ in] screen. Testing as specified in AASHTO T11 shall be performed on any materials for which there is a specification limit on the amount of material passing a 75 μ m [No. 200] sieve.

The Department may require the Contractor to submit, for inclusion into the project records, certification that new Work Zone Category 1 and Category 2 Devices meet National Cooperative Highway Research Program (NCHRP) Report 350 guidelines. Work Zone Category 1 Devices include plastic drums, cones, and tubular markers. Work Zone Category 2 Devices include portable sign stands (with signs), Type I, Type II, and Type III barricades, vertical panels, intrusion alarms, and other work zone devices under 45 kg [100 lb]. All new Work Zone Category 1 and Category 2 Devices purchased by the Contractor shall meet NCHRP Report 350 guidelines.

Vendors/Contractors will be allowed to self-certify Work Zone Category 1 Devices with a letter of self-certification. A letter of self-certification shall contain at a minimum

- a. A title e.g., “Certificate of Crashworthiness”,
- b. Name and Address of the Vendor making certification,
- c. Unique identification of the certificate (such as a serial number) and of each page and the total number of pages,
- d. Description and unambiguous identification of the item tested,
- e. Identification of the basis for the self-certification process used and to what test level of NCHRP 350,
- f. Signature and title of person(s) accepting responsibility for the content of the certificate and date of issue, and
- g. A statement that the certificate shall not be reproduced except in full.

Crash test information is available on the FHWA Office of Highway Safety's Homepage: <http://safety.fhwa.gov/programs/roadsideHardware.htm>.

Contractors may use existing Work Zone Category 1 Devices (purchased before October 1, 1998) until the end of their service life. Existing Work Zone Category 2 Devices (purchased before October 1, 2000) may be used until the end of their service life or October 30, 2003, whichever occurs first. When a device reaches the end of its service life, it shall be replaced with a NCHRP 350 and MUTCD compliant device.

SECTION 701 - STRUCTURAL CONCRETE RELATED MATERIAL

701.01 Portland Cement and Portland Pozzolan Cement Portland cement shall conform to the requirements of AASHTO M85, Type II.

A Type II or Type III cement meeting AASHTO M85 may be used when making precast units.

A Type IP (MS) portland-pozzolan cement (blended hydraulic cement with moderate sulfate resistance) meeting the requirements of AASHTO M240, may be used instead of Type II or where Type I portland cement, meeting the requirements of AASHTO M85, is allowed. The definitions of the two hydraulic cements mentioned above are as follows: (See ASTM C219)

Portland cement - a hydraulic cement produced by pulverizing portland cement clinker, and usually containing calcium sulfate.

Portland-pozzolan cement - a hydraulic cement consisting of an intimate and uniform blend of portland cement or portland blast furnace slag cement and fine pozzolan produced by intergrinding portland cement clinker and pozzolan, by blending portland cement or portland blast furnace slag cement and finely divided pozzolan, or a combination of intergrinding and blending, in which the amount of the pozzolan constituent is within specified limits.

Only one brand of cement shall be used on any one contract unless otherwise permitted, in writing, by the Resident.

701.02 Water Water used in mixing or curing concrete shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetation, or substances injurious to the finished product. If required by the Resident, it shall be tested by comparison with water of known satisfactory quality. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength. Any indication of unsoundness, marked change in time of setting or a reduction of more than 10% in strength from results obtained with mixtures containing water of known satisfactory quality shall be sufficient cause for rejection of the water that is being tested. Water, known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

701.03 Air-Entraining Admixtures Air-entraining admixtures shall be in accordance with the requirements of AASHTO M154.

The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

701.04 Water Reducing Admixtures Water reducing admixtures shall conform to the requirements of AASHTO M194, Type A.

The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

701.0401 High Range, Water Reducing, Admixture High range, water-reducing admixture, commonly referred to as both super-water-reducers and/or superplasticizers, shall conform to the requirements of AASHTO M194, Type F.

The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

701.05 Set-retarding Admixtures Set-retarding admixtures shall conform to the requirements of AASHTO M194, Types B or D.

The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

701.06 Curing Materials Sheet materials for curing concrete shall conform to the requirements of AASHTO M171. Burlap cloth shall conform to the requirements of AASHTO M182 Class 3, 310 g/m [10 oz/yd]. Liquid membrane-forming compounds shall conform to the requirements of AASHTO M148 and shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

The two types of approved liquid membrane-forming compounds are: (1) Type 1-D, clear or translucent with fugitive dye which must be readily distinguishable for at least 4 hours and must be inconspicuous in 7 days and (2) Type 2, white pigmented.

701.07 Waterstops Waterstops shall be polyvinylchloride and conform to the requirements of US Army Corps of Engineers Specification CRD C-572.

701.08 Smooth Surfaced Asphalt Roll Roofing (formerly called Heavy Roofing Felt) Wherever heavy roofing is called for on the plans an approved standard brand of smooth surface asphalt roofing (organic felt) conforming to ASTM D224 Type I.

701.09 Styrene-Butadiene Latex Modifier for Concrete and Mortar The formulated styrene-butadiene latex modifier, hereinafter referred to as latex admixture, shall be a nonhazardous, film forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture, and shall be homogeneous and uniform in composition. This

styrene-butadiene latex modifier shall be used in the mortar or concrete and shall be one of the following:

- (a) Dow Modifier A; Dow Chemical Company; Midland, Michigan
- (b) Deco-Rez 4776; General Polymers Corp.; Cincinnati, Ohio
- (c) Thermoflex 8002 (also called Reichold 8002); Reichold Chemicals, Inc.; Dover, Delaware
- (d) Arco Dyles 1186; Arco Polymers, Inc.; Monaca, Pennsylvania

The prime Contractor shall be responsible for the cooperation and coordination with the latex supplier or manufacturer or both for the satisfactory performance of the work.

The latex admixture formulation shall conform to the following requirements:

Polymer Styrene-butadiene emulsion. $66 \pm 1\frac{1}{2}\%$ styrene, $31\frac{1}{2} \pm 1\frac{1}{2}\%$ butadiene

Percent 46.5 to 49.0%

Stabilizers The polymeric emulsion shall be stabilized with an anionic, nonionic and polyorganosiloxane fluid surfactant in which the anionic surfactant is a sodium alkyl sulfate.

Average Size of Particles 1,900 to 2,500 Angstroms

PH 8.5 to 11.0

Freeze-Thaw Stability 5.0 percent maximum in 300 cycles. AASHTO T 161; except modified with 3 percent. NaCl solution instead of plain water

Shelf life Minimum of 2 years

Color White

Weight per gallon 3.81 to 3.84 kg [8.4 to 8.47 lb] @ 25°C [77°F]

Water AASHTO T 26

Method of Determining Total Solids-Latex Admixture, Percent

Scope This involves the determination of the percent solids on all latex admixture samples. It involves weighing a sample of wet latex admixture, drying in an oven and then expressing the weight ratio of dry/wet in percent.

Procedure

- (a) All samples to be tested must be at room temperature. If the sample is warm, it can be cooled in a pan of cold tap water.

(b) The level of the balance should be checked and adjusted if necessary. In addition, the zero of the balance should be checked and adjusted correspondingly.

(c) Weigh 3 aluminum cups and record the weight of each (tare weight). NOTE: Every sample tested must be done in triplicate.

(d) Mix by hand each sample when cool by inverting the container 5 to 10 times.

(e) Weigh approximately 1 gram [0.035 oz] of latex admixture to the nearest milligram into each preweighed aluminum cup.

(f) Place all 3 samples in the oven to dry for 120 minutes (oven temperature $140 \pm 1^\circ\text{C}$ [$285 \pm 2^\circ\text{F}$]).

(g) Remove the samples from the oven and place immediately in a desiccator for a few minutes or until cool. This prevents moisture pick up from the air while cooling.

(h) Reweigh each sample out of the desiccator to the nearest milligram and record.

(i) Calculations.

$$\text{Total solids in percent} = \frac{C-A}{B-A} \times 100$$

Where:

A - The weight of the empty aluminum cup.

B - The weight of the aluminum cup and the wet sample.

C - The weight of the aluminum cup and the dried sample.

(j) Results

(1) If all three samples are within 2 percent, average the 3 samples to obtain the percent solids.

(2) If all 3 samples are not within 2 percent, but 2 samples are within 1 percent, the average between the 2 samples within 1 percent is reported as the percent solids and the third determination is discarded.

(3) If all 3 samples are not within 2 percent and no 2 are within 1 percent, all the values must be discarded and the solids procedure must be repeated.

701.10 Fly Ash Fly Ash shall conform to the following chemical and physical requirements for mineral admixtures, Class F as listed in AASHTO M295 .

Physical Requirements:

Fineness Amount retained when wet screened on a 45 μm [No. 325] sieve. Maximum 34% allowed as per AASHTO T192.

Strength Activity Index at 7 Days with Portland Cement Meeting a minimum 75% of control.

Autoclave Expansion or Contraction Maximum 0.8% allowed per AASHTO T107 Footnote c shall apply.

Uniformity requirements The specific gravity and fineness of individual samples shall not vary from the average established by the 10 preceding tests, or by the preceding tests if the number is less than 10, by more than 5%.

Chemical Requirements:

Silicon dioxide (SiO₂) plus aluminum oxide (Al₂O₃) plus iron oxide (Fe₂O₃) Shall meet a minimum 70% per AASHTO T105 (ASTM C114).

SO₃ Sulfate ion reported as Sulfur trioxide. Maximum 5% allowed per AASHTO T105 (ASTM C114).

Moisture content Shall be a maximum 3% per AASHTO T105 (ASTM C311)

Loss of ignition (LOI) Shall be 6% maximum per AASHTO T105 (ASTM C311)

Source, Acceptance, Quality Control Conformance to these specifications will be assured by a program of testing, including quality control (QC) exercised by the fly ash producer, and quality acceptance (QA) exercised by the department.

a. Source The fly ash supplier's source shall receive acceptance based on forwarding detailed information on the following.

1. Source of raw materials.
2. Fly ash recovery process and type of collection equipment.
3. Fly ash properties and past variability's.
4. Storage facilities.
5. Frequency and results of suppliers quality control testing program.

b. Acceptance The approval of fly ash we will be based on comparative testing performed by the department on samples obtained from storage silos located at the redimix concrete plants.

Samples will be obtained for testing during the annual plant inspection. Further sampling will be on a per project basis at a frequency to be determined by the department.

c. Quality Control The quality control procedures employed by the supplier shall be such that only fly ash conforming to this Section is presented to the department for acceptance consideration.

701.11 Calcium Nitrite Solution Calcium nitrite solutions shall conform to the requirements of AASHTO M194, Type C (accelerating admixtures). An approved calcium nitrite based corrosion inhibitor shall be added to the concrete mix as an aqueous solution.

The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

701.12 Silica Fume The silica fume material for use in Portland Cement Concrete shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

701.13 Ground Granulated Blast Furnace Slag Ground granulated blast furnace slag shall conform to the following chemical and physical requirements for mineral admixtures, Grade 120 as listed in AASHTO M302.

Physical Requirements:

Fineness Amount retained when wet screened on a 45 µm [No. 325] sieve. Maximum 20% allowed as per AASHTO T192 (ASTM C430)

Air Content Air content of slag mortar mix. Maximum 12% allowed as per AASHTO T137 (ASTM C185)

Strength Activity Index Meeting the requirements listed in AASHTO M302 (ASTM C989) Table No. 1.

Chemical Requirements:

SO³ Sulfate ion reported as Sulfur Trioxide. Maximum 4% allowed as per AASHTO T105 (ASTM C114)

Source, Acceptance, Quality Control Conformance to these specifications will be assured by a program of testing, including quality control (QC) exercised by the slag producer, and quality acceptance (QA) exercised by the department.

a. Source The Slag supplier's source shall receive acceptance based on forwarding detailed information on the following.

1. Source of raw materials.
2. Slag recovery process and type of collection equipment.
3. Slag properties and past variability's.
4. Storage facilities.
5. Frequency and results of suppliers quality control testing program.

b. Acceptance The approval of slag we will be based on comparative testing performed by the department on samples obtained from storage silos located at the redi-mix concrete plants.

Samples will be obtained for testing during the annual plant inspection. Further sampling will be on a per project basis at a frequency to be determined by the department.

c. Quality Control The quality control procedures employed by the supplier shall be such that only slag conforming to this Section is presented to the department for acceptance consideration.

SECTION 702 - BITUMINOUS MATERIAL

702.01 Asphalt Cement Performance Graded Asphalt Binder shall conform to the requirements of AASHTO M 320.

702.03 Cutback Asphalt AASHTO M82.

702.04 Emulsified Asphalt AASHTO M140. Cationic emulsified asphalt shall conform to AASHTO M208.

702.05 Temperature Application Range, °C [°F]

<i>Type and Grade of Material</i>	<i>Spray</i>	<i>Mix</i>
RC 70	27 to 66 [80 to 150]	27 to 66 [80 to 150]
RC 250	28 to 79 [82 to 175]	27 to 66 [80 to 150]
RC 800	71 to 107 [160 to 225]	57 to 85 [135 to 185]
RC 3000	93 to 135 [200 to 275]	85 to 107 [185 to 225]
MC 30	10 to 49 [50 to 120]	10 to 49 [50 to 120]
MC 70	27 to 66 [80 to 150]	27 to 66 [80 to 150]
MC 250	38 to 93 [100 to 200]	38 to 99 [100 to 210]
MC 800	85 to 127 [185 to 260]	93 to 121 [200 to 250]
MC 3000	109 to 135 [230 to 275]	93 to 121 [200 to 250]
All emulsions	10 to 71 [50 to 160]	10 to 71 [50 to 160]
Performance Graded Asphalt Binder (all grades)		As required to achieve a viscosity of 0.15 to 0.31 PA-s.

702.06 Temperature - Volume Correction Tables All asphalt material shall be corrected for volume by use of the following multipliers to reduce the volume at the observed temperature to the volume at 16°C [60°F].

EMULSIFIED ASPHALTS	ASPHALTS (from ASTM D1250)		ASPHALTS (from ASTM D1250)		ASPHALTS (from ASTM D1250)				
	All Types and Grades	T °C [°F]	Group0 Sp. Grave. 0.966+	Group1 Sp. Grave. 0.850 0.966	T °C [°F]	Group0 Sp. Grave. 0.966+	Group1 Sp. Grave. 0.850 0.966		
1	10 [50]	1.0035	1.0040	66 [150]	.9689	.9647	121 [250]	.9352	.9268
1	13 [55]	1.0017	1.0020	68 [155]	.9672	.9628	124 [255]	.9336	.9249
1.0000	16 [60]	1.0000	1.0000	71 [160]	.9655	.9609	127 [260]	.9319	.9231
.9988	18 [65]	.9983	.9980	74 [165]	.9638	.9589	129 [265]	.9302	.9212
.9975	21 [70]	.9965	.9960	77 [170]	.9621	.9570	132 [270]	.9286	.9194
.9962	24 [75]	.9948	.9940	79 [175]	.9604	.9551	135 [275]	.9269	.9175
.9950	27 [80]	.9930	.9921	82 [180]	.9587	.9532	138 [280]	.9253	.9157
.9938	29 [85]	.9913	.9901	85 [185]	.9570	.9513	141 [285]	.9236	.9138
.9925	32 [90]	.9896	.9881	88 [190]	.9553	.9494	143 [290]	.9220	.9120
.9912	35 [95]	.9878	.9861	91 [195]	.9536	.9475	146 [295]	.9204	.9102
.9900	38 [100]	.9861	.9842	93 [200]	.9520	.9456	149 [300]	.9187	.9083
.9988	41 [105]	.9844	.9822	96 [205]	.9503	.9437	152 [305]	.9171	.9065
.9875	43 [110]	.9826	.9803	99 [210]	.9486	.9418	154 [310]	.9154	.9047
.9862	46 [115]	.9809	.9783	102 [215]	.9469	.9399	157 [315]	.9138	.9029
.9850	49 [120]	.9792	.9763	104 [220]	.9452	.9380	160 [320]	.9122	.9010
.9338	52 [125]	.9775	.9744	107 [225]	.9436	.9361	163 [325]	.9105	.8992
.9825	54 [130]	.9758	.9725	110 [230]	.9419	.9343	166 [330]	.9089	.8974
.9812	57 [135]	.9740	.9705	113 [235]	.9402	.9324	168 [335]	.9073	.8956
.9800	60 [140]	.9723	.9686	116 [240]	.9385	.9305	171 [340]	.9057	.8938
.9788	63 [145]	.9706	.9666	118 [245]	.9369	.9286	174 [345]	.9040	.8920
.9775	66 [150]	.9689	.9647	121 [250]	.9352	.9268	177 [350]	.9024	.8902

702.09 Asphalt Filler for Structural Plate Arches Asphalt for filling spaces between the structural plates and the substructure metal connectors of the arch shall conform to the requirements for bituminous material of AASHTO M190 or of AASHTO M320, Table 1, for PG 64-28.

702.12 Emulsified Asphalt Sealing Compound Emulsified asphalt sealing compound shall be an approved commercially prepared product manufactured for specific protective coating, colored as required. It shall contain fillers, pigments and sand or fibrous materials suspended in a suitable emulsified asphalt or tar. It shall be of such consistency that it can be applied at atmospheric temperatures and capable of being easily diluted with the addition of water and mixed by hand stirring at the site of application.

SECTION 703 - AGGREGATES

703.01 Fine Aggregate for Concrete Fine aggregate for concrete shall consist of natural sand or, when approved by the Resident, other inert materials with similar characteristics or combinations thereof, having strong, durable particles. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix without permission of the Resident.

All fine aggregate shall be free from injurious amounts of organic impurities. Should the fine aggregate, when subjected to the colorimetric test for organic impurities, AASHTO T21 (ASTM C40), produce a color darker than the reference standard color solution (laboratory designation Plate III), the fine aggregate shall be rejected.

The fine aggregate shall be well graded from coarse to fine material and shall meet the following grading requirements when tested according to AASHTO T11 and AASHTO T27.

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	US Customary	
9.5 mm	¾ inch	100
4.75 mm	No. 4	95-100
2.36 mm	No. 8	80-100
1.18 mm	No. 16	50-85
600 µm	No. 30	25-60
300 µm	No. 50	10-30
150 µm	No. 100	2-10
75 µm	No. 200	0-5.0

Fine aggregate failing to meet the minimum requirements for material passing the 300 µm and/or 150 µm [No. 50 and/or No. 100] sieves may be retested and approved for use provided an approved inorganic fine material is added to correct the deficiency in grading.

The gradation requirements given above are the extreme limits to be used in determining the suitability of materials from all possible sources of supply.

The fineness modulus shall not be less than 2.3 or more than 3.1, nor vary by more than 0.20 from the value assumed in selecting proportions of the concrete. If this value is exceeded, the fine aggregate will be rejected unless suitable adjustments are made in proportions of coarse and fine aggregate. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages of material by weight retained on the following sieves: 4.75 mm, 2.36 mm, 1.18 mm, 600 µm, 300 µm and 150 µm [US Standard sieves Nos. 4, 8, 16, 30, 50, 100] and dividing by 100.

Mortar cubes containing the fine aggregates and made according to AASHTO T71 (ASTM C87) using cement conforming to AASHTO M85, Type II, shall develop compressive strength, at the age of 7 days, of not less than 90% of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 +/- 0.10. After the initial test for each year and the fine aggregate has been accepted, the above compressive test will not be required unless the Resident deems it necessary.

Fine aggregate, from an individual source or stockpile used for blending when tested for absorption as specified in AASHTO T84 (ASTM C128), shall show a percent of absorption of not more than 2.30.

703.02 Coarse Aggregate for Concrete Coarse aggregate for concrete shall consist of crushed stone or gravel having hard, strong, durable pieces, free from adherent coatings and of which the portion retained on the 9.5 mm [³/₈ in] sieve shall contain not more than 15%, by weight of flat and elongated particles when performed in accordance with test method ASTM D4791, Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate, using a dimensional ratio of 1:5.

The coarse aggregate shall not contain more than 3%, by weight, of deleterious material from an individual or blended source or stockpile.

Deleterious material is defined as those particles of aggregate that may be crumbled in the hand and those that have an absorption greater than 3% by weight determined in accordance with AASHTO T85 modified for weight of sample. The types that are determined to be deleterious are generally highly absorptive shales, phylites, sandstones, and rotten rock of various kinds.

Coarse aggregate shall conform to the requirements of the following table for the size or sizes designated and shall be well graded between the limits specified.

PERCENTAGE BY WEIGHT PASSING A SQUARE MESH SIEVE

CLASSES	A	AA	S	LATEX
Sieve Designation				
50.0 mm [2 in]			100	
37.5 mm [1½ in]	100		95-100	
25.0 mm [1 in]	95-100	100	-	
19.0 mm [³ / ₄ in]	-	90-100	35-70	100
12.5 mm. [¹ / ₂ in]	25-60	-	-	90-100
9.5 mm [³ / ₈ in]	-	20-55	10-30	40-70
4.75 mm [No. 4]	0-10	0-10	0-5	0-15
2.36 mm [No. 8]	0-5	0-5	-	0-5
1.18 mm [No. 16]	-	-	-	-
300 µm [No. 50]	-	-	-	-
75 µm [No. 200]	1.5 Max.	1.5	1.5	1.5
AGG. SIZE	25mm[1 in]	19mm[¾ in]	37.5mm[1½ in]	12.5mm[½ in]

The material passing the 75 µm [No. 200] sieve shall be determined in accordance with AASHTO T11 and AASHTO T27.

Coarse aggregate for a non-integral structural concrete wearing surface shall be hard and durable crushed ledge rock.

703.0201 Alkali Silica Reactive Aggregates. All coarse aggregates proposed for use in concrete shall be tested for Alkali Silica Reactivity (ASR) potential under AASHTO T303 (ASTM C1260), Accelerated Mortar Bar Method, prior to being accepted for use. Acceptance will be based on testing performed by the Department. Sampling will be performed by the Department from stockpiles located at the Contractor's/supplier's ready mixed concrete plants. Aggregate approvals will be performed on a 3-year cycle, unless the source or character of the aggregate in question has changed within 3 years from the last test date.

A list of pre-approved coarse aggregate and aggregate-cement/pozzolan blends is maintained by the Department and will determine the acceptability of concrete mix designs proposed for use.

As per AASHTO T303 (ASTM C1260): Use of a particular coarse aggregate will be allowed with no restrictions when the mortar bars made with this aggregate expand less than or equal to 0.10% at 16 days; use of a particular coarse aggregate will be classified as potentially reactive when the mortar bars made with this aggregate expand greater than 0.10% at 16 days, and use of this aggregate will be allowed only with the use of cement-pozzolan blends and/or chemical admixtures that result in mortar bar expansion of less than 0.10% at 16 days.

Acceptable pozzolans and chemical admixtures that may be used when an aggregate is classified as potentially reactive include, but are not limited to, the following:

- A. Class F Coal Fly Ash meeting the requirements of ASTM C618.
- B. Ground Granulated Blast Furnace Slag (Grade 100 and 120) meeting the requirements of ASTM C989.
- C. Densified Silica Fume (powder or slurry) meeting the requirements of AASHTO M307.
- D. Lithium Hydroxide Monohydrate (LiOH-H₂O).

Pozzolans or chemical admixtures required to offset the effects of potentially reactive aggregates will be incorporated into the concrete at no additional cost to the Department.

Aggregates classified as potentially reactive by the requirements of this specification may be used, provided they meet one of the following criteria:

- A. A well-documented history showing that the proposed aggregate is innocuous is provided to the Department of at least 10 structures containing this aggregate. These structures must be at least 15 years of age, exposed to moisture in service, contain high alkali cement (greater than 0.80% alkali) and exhibit a lack of ASR-related distress. Cores taken from the existing structures shall be petrographically analyzed

in accordance with ASTM C856; these analyses must indicate the absence of ASR gel formation, aggregate rimming and associated micro cracking. The locations and sampling of cores shall be the responsibility of the Department. All costs associated with the petrographic evaluation of cores, including transportation of the cores to the testing facility, shall be the responsibility of the Contractor.

- B. Certified test results from an accredited independent laboratory utilizing the current AASHTO T303 (ASTM C1260) Accelerated Mortar Bar Method, indicating an acceptable alkali-aggregate combination, are submitted to the Department.

703.05 Aggregate for Sand Leveling Aggregate for sand leveling shall be sand of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation shall meet the grading requirements of the following table.

Sieve Designation		Percent by Weight Passing Square Mesh Sieve
Metric	US Customary	
9.5 mm	3/8 in	85-10
75 µm	No. 200	0-5.0

703.06 Aggregate for Base and Subbase. The material shall have a minimum degradation value of 15 as determined by the Washington State Degradation Test of 1967, except that the test will be run on the portion of a sample that passes the 12.5 mm [1/2 in] sieve and is retained on the 2.00 mm [No. 10] sieve, minus any reclaimed asphalt pavement used.

- a. Aggregate for base shall be screened or crushed gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 75 mm [3 in] sieve shall meet the grading requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves		
Metric	US Customary	Aggregates		
		Type A	Type B	Type C
12.5 mm	1/2 in	45-70	35-75	
6.3 mm	1/4 in	30-55	25-60	25-70
425 µm	No. 40	0-20	0-25	0-30
75 µm	No. 200	0-5.0	0-5.0	0-5.0

Type A aggregate for base shall only contain particles of rock that will pass the 50 mm [2 in] square mesh sieve.

Type B aggregate for base shall only contain particles of rock that will pass the 100 mm [4 in] square mesh sieve.

Type C aggregate for base shall only contain particles of rock that will pass the 150 mm [6 in] square mesh sieve.

b. Aggregate for subbase shall be sand or gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 75 mm [3 in] sieve shall meet the grading requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves			
Metric	US Customary	Aggregates			
		Type D	Type E	Type F	Type G
6.3 mm	¼ in	25-70	25-100	60-100	-
425 µm	No. 40	0-30	0-50	0-50	0-70
75 µm	No. 200	0-7.0	0-7.0	0-7.0	0-10.0

Aggregate for subbase shall not contain particles of rock which will not pass the 150 mm [6 in] square mesh sieve.

703.07 Aggregates for HMA Pavements Coarse aggregate and fine aggregate for hot mix asphalt pavements shall be of such gradation that when combined in the proper proportions, including filler, if required, the resultant blend will meet the composition of mixture for the type of pavement specified.

Coarse aggregate, that material retained on the 2.36 mm [No. 8] sieve, shall be crushed stone or crushed gravel and, unless otherwise stipulated, shall consist of clean, tough, durable fragments free from an excess of soft or disintegrated pieces and free from stone coated with dirt or other objectionable matter.

Fine aggregate, material that passes the 2.36 mm [No. 8] sieve, shall consist of natural sand, manufactured sand, or a combination of these. It shall consist of hard, tough grains, free from injurious amounts of clay, loam, or other deleterious substances. Fine aggregate, shall not exceed an absorption of 3% by weight as determined by AASHTO T84.

The composite blend shall have a Micro-Deval value of 18.0 or less as determined by AASHTO TP58-99. In the event of a failure, the Washington State Degradation test of 1967 shall be run before rejection of the material. Material with a value of 30 or more may be accepted.

Aggregates shall also meet the following consensus properties. The Department reserves the right to sample and test the composite aggregate for any of the following properties at any time.

TABLE 3: AGGREGATE CONSENSUS PROPERTIES CRITERIA

Estimated Traffic, Million 80 kN [18 kip] ESALs	ASTM D5821 Coarse Aggregate Angularity (Minimum)	AASHTO T-304 Method A Uncompacted Void Content of Fine Aggregate (Min)	ASTM D4791 (8.4) Flat and Elongated Particles (Maximum)	AASHTO T176 Clay Content/ Sand Equivalent (Minimum)
< 0.3	60/60	40	10	45
0.3 to < 3.0	75/60			
3.0 to < 10	85/80			
10 to < 30	95/90			
≥ 30	100/100	45		50

ASTM D5821 - “85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two fractured faces.

AASHTO TP304 - Criteria are presented as percent air voids in loosely compacted fine aggregate, (U).

ASTM 4791 - Criteria are presented as maximum percent by weight of flat and elongated particles (5:1 ratio).

The entire HMA wearing course shall come from the same source of material and the same job mix formula, except when permission is obtained from the Resident to change sources.

703.09 HMA Mixture Composition The coarse and fine aggregate shall meet the requirements of Section 703.07. The several aggregate fractions for mixtures shall be sized, graded, and combined in such proportions that the resulting composite blends will meet the grading requirements of the following tables or as otherwise specified.

TABLE 1: COMPOSITION OF MIXTURES - CONTROL POINTS

SIEVE SIZE	GRADING			
	TYPE 19 mm	TYPE 12.5 mm	TYPE 9.5 mm	TYPE 4.75 mm
	PERCENT BY WEIGHT PASSING - COMBINED AGGREGATE			
37.5 mm	100	100	100	100
25 mm	90-100	100	100	100
19 mm	-90	90-100	100	100
12.5 mm	-	-90	90-100	95-100
9.5 mm	-	-	-90	80-100
4.75 mm	23-49	28-58	32-67	40 - 80
2.36 mm	-	-	-	-
1.18 mm	-	-	-	-
600 µm	-	-	-	-
300 µm	-	-	-	-
75 µm	2-8	2-10	2-10	2-10

SIEVE SIZE	RESTRICTED ZONES			
	TYPE 19 mm [¾ in]	TYPE 12.5 mm [½ in]	*TYPE 9.5 mm [⅜ in]	TYPE 4.75 mm [#40]
	PERCENT BY WEIGHT PASSING - COMBINED			AGGREGATE
37.5 mm [1½ in]	-	-	-	-
25 mm [1 in]	-	-	-	-
19 mm [¾ in]	-	-	-	-
12.5 mm [½ in]	-	-	-	-
9.5 mm [⅜ in]	-	-	-	-
4.75 mm [No. 4]	-	-	-	-
2.36 mm [No. 8]	34.6	39.1	47.2	-
1.18 mm [No. 16]	22.3-28.3	25.6-31.6	31.6-37.6	-
600 µm [No. 30]	16.7-20.7	19.1-23.1	23.5-27.5	-
300 µm [No. 50]	13.7	15.5	18.7	-
75 µm [No. 200]	-	-	-	-

* The restricted zone is presented for information and definition of “Fine” 9.5mm mixes only.

If a Grading “D” mixture is allowed per Special Provision Section 403, it shall meet the following gradation and the aggregate requirements of Section 703.07.

Sieve Designation (Metric)	Sieve Designation (US Customary)	Percentage by Weight Passing Square Mesh Sieves
12.5 mm	½ in	100
9.5 mm	⅜ in	93-100
4.75mm	No. 4	60-80
2.36 mm	No. 8	46-65
1.18 mm	No. 16	25-55
600 µm	No. 30	16-40
300 µm	No. 50	10-30
150 µm	No. 100	6-22
75 µm	No. 200	3.0-8.0

703.10 Aggregate for Untreated Surface Course and Leveling Course Aggregate for untreated surface course and leveling course shall be screened or crushed gravel consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the material shall meet the grading requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	US Customary	
25.0 mm	1 in	95-100
19.0 mm	¾ in	90-100
4.75 mm	No. 4	40-65
2.00 mm	No. 10	10-45
75 µm	No. 200	0-7.0

703.11 Aggregate for Shoulder Aggregate for add shoulder gravel shall meet the grading requirements of the following table.

*Paved or Unpaved Lifts 100 mm [4 in] or Greater	Paved Lifts < 100 mm [4 in]	Unpaved Lifts < 100 mm [4 in]
Percent Passing	Percent Passing	Percent Passing
25 mm [1 in]	90 - 100	90 - 100
6.3 mm [¼ in]	25 - 100	25 - 70
425µm [No. 40]	5 - 50	5 - 30
75µm [No. 200]	2 - 10	2 - 10

*Shall not contain particles larger than 150 mm [6 in] or the thickness of the lift being placed, whichever is less.

703.12 Aggregate for Crushed Stone Surface Crushed stone surface shall be of quarried stone and meet the applicable requirements of Section 703.07(a) Coarse Aggregate. The aggregate shall meet the following gradation requirements:

Sieve Designation	Percent of Weight Passing Square Mesh Sieves
25 mm [1 in]	100
19 mm [¾ in]	60 - 90
12.5 mm [½ in]	10 - 35
9.5 mm [⅜ in]	2 - 15
4.75 mm [No. 4]	0 - 5

Gradation tests shall conform to AASHTO Method T27.

703.15 Filler These materials shall conform to the following specification requirements for the designated materials.

Mineral filler shall conform to the requirements of AASHTO M17.

703.18 Common Borrow Common borrow shall consist of earth, suitable for embankment construction. It shall be free from frozen material, perishable rubbish, peat and other unsuitable material.

The moisture content shall be sufficient to provide the required compaction and stable embankment. In no case shall the moisture content exceed 4% above optimum, which shall be determined in accordance with AASHTO T180, Method C or D.

703.19 Granular Borrow Granular borrow shall consist of sand or gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of that portion passing a 75 mm [3 in] sieve shall meet the gradation requirements of the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves	
Metric	US Customary	Material for Underwater Backfill	Material for Embankment Construction
425 µm	No. 40	0-70	0-70
75 µm	No. 200	0-10.0	0-20.0

Granular borrow shall contain no particles or fragments with a maximum dimension in excess of the compacted thickness of the layer being placed.

703.20 Gravel Borrow Gravel borrow shall consist of well graded granular material having no rocks with a maximum dimension of over 150 mm [6 in] and that portion passing a 75 mm [3 in] square mesh sieve shall contain not more than 70% passing a 6.3 mm [¼ in] mesh sieve and not more than 10% passing a 75 µm [No. 200] mesh sieve.

703.21 Rock Borrow Rock borrow shall consist of hard durable rock broken to various sizes that will form a compact embankment with a minimum of voids. The maximum size for any rock shall be 900 mm [3 ft] in its greatest dimension.

703.22 Underdrain Backfill Material. Granular material for Underdrain Type B shall be free from organic matter and shall conform to the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
25.0 mm [1 in]	95-100
12.5 mm [½ in]	75-100
4.75 mm [No. 4]	50-100
850 µm [No. 20]	15-80
300 µm [No. 50]	0-15
75 µm [No. 200]	0-5.0

Crushed or uncrushed material for Underdrain Type C shall conform to the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	US Customary	
25.0 mm	1 in	100
19.0 mm	¾ in	90-100
9.5 mm	⅜ in	0-75
4.75 mm	No. 4	0-25
2.00 mm	No. 10	0-5

703.24 Stone for French Drains Stones for French drains shall consist of hard, durable rock and shall conform to the following table:

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	US Customary	
150 mm	6 in	90-100
37.5 mm	1½ in	0-40
4.75 mm	No. 4	0-5

Gradation test shall conform to AASHTO T27 except that the total sample shall be sieved and the minimum weight of the sample will be 55 kg [120 lb].

703.25 Stone Fill Stones for stone fill shall consist of sound durable rock that will not disintegrate by exposure to water or weather. Either field stone or rough, unhewn quarry stone may be used. Stones shall weigh from 5 kg [10 lb] to a maximum of 225 kg [500 lb] or larger if approved by the Resident. 50 percent by weight of the stones shall be approximately 100 kg [200 lb].

703.26 Plain and Hand Laid Riprap Stones shall consist of sound durable rock which will not disintegrate by exposure to water or weather. Either field stone or rough, unhewn quarry stone may be used. Exposed stones shall be angular and as nearly rectangular in cross-section as practicable. Rounded boulders or cobbles will not be permitted. Stones shall weigh from 5 kg [10 lb] to 100 kg [200 lb] except that when available suitable stones weighing more than 90 kg [200 lb] may be used. Approximately 50% of the stones by volume, shall exceed a mass of 25 kg [50 lb] each.

703.27 Stone Blanket Stones shall consist of sound durable rock that will not disintegrate by exposure to water or wind. Either field stone or rough, unhewn quarry stone may be used. Stones shall weigh from 150 kg [300 lb] to 1500 kg [3,000 lb]. Approximately 50% of the stones, by volume, shall exceed a mass of 450 kg [1,000 lb] each.

703.28 Heavy Riprap Stones shall consist of sound, durable rock, resistant to the action of air and water. Either field stone or rough, unhewn quarry stone may be used. The exposed stones shall be angular. Round or thin, flat stones will not be permitted. Stones shall have a minimum weight of 225 kg [500 lb] each and at least 50% of the stones, by volume, shall exceed 450 kg [1,000 lb] each.

703.29 Stone Ditch Protection Rock used for ditch protection shall consist of sound, durable rock that will not disintegrate by exposure to water or weather. Fieldstone, rough quarry stone, blasted ledge rock or tailings may be used. The rock shall be graded within the following limits or as otherwise approved.

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	US Customary	
300 mm	12 in	90-100
100 mm	4 in	0-15

The size of any stone shall not exceed 450 mm [18 in] when measured along its longest axis.

703.31 Crushed Stone Crushed stone shall be obtained from rock of uniform quality and shall consist of clean, angular fragments of quarried rock, free from soft disintegrated pieces or other objectionable matter.

The stone, which shall be similar to railroad ballast, shall meet the following gradation requirements in the stockpile at the source.

Sieve Designation		Percentage by Weight Passing Square Mesh Sieves
Metric	US Customary	
63 mm	2½ in	100
50 mm	2 in	95-100
25 mm	1 in	0-30
19 mm	¾ in	0-5

SECTION 704 - MASONRY UNITS

704.01 Clay or Shale Brick Except as modified below, brick shall conform to the requirements of one of the following specifications:

Type of Brick	Specification
Sewer and Manhole Building	AASHTO M91, Grade MS or SM AASHTO M114, Grade SW

Size Number 1 brick of a nominal length of 190 mm [7 in] may be used.

704.02 Brick for Paving Brick for paving shall conform to the requirements of ASTM (C62, Grade SW) for Building brick or shale, with the following modifications:

- a. The absorption limits shall be from 5% to 12% for the average of 5 bricks.
- b. The compressive strength shall not be less than 41.4 MPa [6,000 psi].
- c. The modulus of rupture shall not be less than 6.9 MPa [1,000 psi].
- d. The bricks shall be No. 1, water struck type for paving.

The bricks shall be 57 mm by 90 mm by 190 mm [2¼ in by 3¾ in by 8 in] with permissible variations not to exceed 1.5 mm [¹/₁₆ in] in depth, 3 mm [¹/₈ in] in width and 6 mm [¹/₄ in] in length.

Before ordering new brick, samples shall be submitted in whole straps to show color range.

704.03 Concrete Masonry Blocks Concrete masonry blocks may be rectangular or segmented and when specified shall have ends shaped to provide interlock at vertical joints.

Hollow blocks shall conform to the requirements of ASTM C90, Grade N-II, except paragraph 3.2 a. Aggregates shall meet the requirements of Sections 703.01 and 703.02 for fine aggregates and coarse aggregates respectively except that grading requirements are hereby waived.

Solid blocks for catch basins and manholes shall conform to the requirements of ASTM C139.

SECTION 705 - JOINT MATERIAL

705.01 Preformed Expansion Joint Filler Preformed expansion joint filler shall be non-extruding and resilient bituminous type and shall conform to the requirements of AASHTO M213 (ASTM D1751).

705.02 Joint Mortar Joint mortar shall consist of 1 part Portland cement, 2 parts sand and sufficient water to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

The cement shall conform to the requirements of Portland cement AASHTO M85 (ASTM C150), Type II or IIA.

The sand shall meet the requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve	
	Joints Thicker Than 13 mm [$\frac{1}{2}$ in]	Joints 13 mm [$\frac{1}{2}$ in] or Thinner
9.5 mm [$\frac{3}{8}$ in]	100	-
6.3 mm [$\frac{1}{4}$ in]	-	100
4.75 mm [No. 4]	95-100	-
2.36 mm [No. 8]	70-95	85-100
1.18 mm [No. 16]	45-80	60-90
600 μ m [No. 30]	25-55	35-70
300 μ m [No. 50]	10-30	15-45
150 μ m [No. 100]	2-10	0-15
75 μ m [No. 200]	0-5	0-5

When necessary, material retained on the 4.75 mm [No. 4] sieve may be removed.

The sand shall be subjected to the colorimetric test for organic impurities, AASHTO T21 (ASTM C40), and when a color darker than the reference standard color solution (laboratory designation Plate III) is produced, the material shall be rejected.

705.03 Flexible Gaskets Flexible gaskets, either rubber or plastic, shall conform to AASHTO M198 (ASTM C990).

SECTION 706 - NON-METALLIC PIPE

706.02 Reinforced Concrete Pipe This pipe shall conform to the requirements of AASHTO M170M/M170 (ASTM C76M/C76). Elliptical pipe shall conform to the requirements of AASHTO M207M/M207. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional. Pipe arch shall conform to the requirements of AASHTO M206M/M206.

Aggregates shall meet the requirements of Section 703.01 and Section 703.02 for fine aggregates and coarse aggregates respectively, except that grading requirements are hereby waived.

Precast reinforced concrete special sections shall conform to the requirements of the cited specifications to the extent to which they apply.

706.06 Corrugated Polyethylene Pipe for Underdrain, Option I, and Option III Culvert Pipe This pipe and fittings shall conform to the requirements of AASHTO M252, slot-perforated for 150 mm [6 in] diameter and to AASHTO M294 for 300 mm diameters to 900 mm [12 in to 48 in]. Pipe used for Option III will meet the requirements of AASHTO M294 Type S, Dual Wall. Pipe to be used for Underdrain Type C shall be perforated in accordance with the applicable perforation requirements of AASHTO M294, Class I perforations. All polyethylene pipe shall be smooth lined and shall meet the pipe stiffness requirements shown on the Standard Details.

This pipe and resins shall meet the requirements of certification under the Plastic Pipe Institute Third Party Certification Program or the American Association of State Highway Transportation Officials National Transportation Product Evaluation Program

706.08 PVC (Polyvinylchloride) Pipe This pipe and fittings shall conform to the requirements of AASHTO M278. All pipe shall be supplied with gasket type joints.

706.09 PVC (Polyvinylchloride) Perforated Pipe This pipe and fittings shall conform to the requirements of AASHTO M278 or ASTM F949 for 150 mm [6 in] underdrain and AASHTO M278 for underdrain larger than 150 mm [6 in] diameter.

SECTION 707 - METALLIC PIPE

707.02 Corrugated Steel, Metallic Coated Pipe This pipe and special fittings such as elbows, tees, and wyes shall conform to the requirements of AASHTO M36/M36M Type I, IR, II, or III for the specified sectional dimensions, sheet thickness, and coating.

707.05 Corrugated Steel, Metallic Coated Pipe for Underdrain This pipe and special fittings such as elbows, tees, and wyes shall conform to the requirements of AASHTO M36/M36M, Type III, Class 1 perforations.

707.06 Corrugated Aluminum Alloy Pipe and Pipe Arches This pipe and special fittings such as elbows, tees, and wyes shall conform to the requirements of AASHTO M196/M196M, Type I, IR, or II. Special sections, such as elbows and metal end sections, shall be of the thickness called for on the plans and shall conform to the applicable requirements of AASHTO M196/M196M. Aluminum sheet shall conform to the requirements of AASHTO M197/M197M.

707.07 Polymer Precoated, Galvanized Corrugated Steel Pipe and Pipe Arches This pipe and special fittings such as elbows, tees and wyes shall conform to the requirements of AASHTO M245/M245M, Grade 250/75 (Type I, with Type B coating) for the pipe as specified in AASHTO M246/M246M with the thinner coating on the outside.

707.08 Corrugated Aluminum Alloy Pipe for Underdrain This pipe and special fittings such as elbows, tees, and wyes shall conform to the requirements of AASHTO M196/M196M, Type III, Class 1 perforations or Type IIIR, Class 4 perforations.

707.09 Steel Structural Plate Pipe, Pipe Arches, Box Culverts, Fasteners, and Arches Plates, bolts, nuts and other accessories shall conform to the requirements of AASHTO M167/M167M and the following additional requirements:

- a. All shop welding shall meet the requirements of the latest edition of AWS D1.1, Structural Welding Code - Steel.
- b. Annually, the fabricator shall have quality control tests performed on uncoated random samples of the lightest and heaviest thickness plates produced by welding.

The sampling and testing shall be done by a recognized independent testing agency and copies of the test reports, including all welding parameters, shall be submitted to the Engineer on an annual basis.

- c. The Engineer reserves the right to conduct unannounced inspections of the fabricators facilities and to take random samples of welded plates representative of gages supplied to the Department.
- d. No field welding will be allowed.

707.10 Aluminum Coated (Type 2) Corrugated Steel Pipe This pipe shall conform to the requirements of AASHTO M36/M36M using steel sheet conforming to AASHTO M274.

707.11 Zinc - Coated (Galvanized) Corrugated Steel Pipe This pipe shall conform to the requirements of AASHTO M36/M36M using steel sheet conforming to AASHTO M218.

707.14 Aluminum Alloy Structural Plate Pipe, Pipe Arches, Box Culverts, Fasteners and Arches Plates for this pipe shall conform to the requirements of AASHTO M219/M219M (ASTM B746/B746M). Bolts and nuts shall conform to the requirements of ASTM F468M alloy 6061-T6 and F467 alloy 6061-T6.

SECTION 708 - PAINTS AND PRESERVATIVES

708.01 Exterior Ready Mixed Paint Exterior paint for wood structures should be a good quality house paint approved by the Resident.

708.03 Pavement Marking Paint Paint for final and temporary pavement marking shall meet the requirements of AASHTO M248. Either Type N, regular dry traffic paint or Type F, fast dry traffic paint may be used.

Glass beads shall conform to the requirements of AASHTO M247, Type I.

708.04 Tree Wound Paint Tree wound paint shall be an approved waterproof, adhesive, and elastic paint, manufactured and customarily used for painting cuts on trees. It shall contain an antiseptic ingredient and be free from kerosene, creosote, coal tar, or any other injurious material.

708.05 Timber Preservative Timber preservatives shall conform to the requirements of AASHTO M133.

SECTION 709 - REINFORCING STEEL AND WELDED STEEL WIRE FABRIC

709.01 Reinforcing Steel Reinforcing steel, both plain and epoxy coated, shall be deformed bars conforming to the requirements of AASHTO M31/M31M (ASTM A615/A615M). Bars shall be Grade 420 [Grade 60] unless otherwise specified on the plans. Epoxy coated reinforcing steel shall also conform to the requirements of AASHTO M284/M284M (ASTM

A775/A775M). The requirements of AASHTO M284/M284M (ASTM A775/A775M), Sections 5.2.1, 5.3, 5.4, and 15.1 shall be mandatory.

Fabricated deformed steel bar mats shall conform to the requirements of AASHTO M54/M54M (ASTM A184/A184M).

709.02 Welded Steel Wire Fabric Welded steel wire fabric shall meet the requirements of AASHTO M55 (ASTM A185) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement or AASHTO M221 (ASTM A497) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement as specified.

709.03 Steel Strand Prestressing strand shall meet the requirements of AASHTO M203M/M203 (ASTM A416/A416M) Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement.

Lateral post-tensioned strands for pre-cast/post-tensioned concrete products shall be 12mm [$\frac{1}{2}$ inch] AASHTO M203M/M203 (ASTM A416/A416M) strand with a corrosion inhibitive coating covered with an extruded polypropylene sheath.

SECTION 710 - FENCE AND GUARDRAIL

710.01 Barbed Wire Barbed wire shall conform to the requirements of ASTM A121, Class 3 if zinc coated or ASTM A585, Class I if aluminum coated. The wire shall be 12½ gage, 4 point round barbs wrapped around both wires, interlocked with one barb projecting through the strand and spaced 150 mm [6 in] apart or less.

710.02 Woven Wire Wire and stays shall conform to the requirements of ASTM A116, Class 3 if zinc coated or ASTM A584, if aluminum coated.

710.03 Chain Link Fabric Chain Link fabric shall conform to the requirements of AASHTO M181, Type I, Class D, or Type II.

710.04 Metal Beam Rail The rails shall conform to the requirements of AASHTO M180, Class A, Type I, or Type IV as designated.

When metal beam rail is to be installed on a curve having a radius of curvature of 45 m [150 ft] or less, the beam sections shall be fabricated on an arc to the required radius.

710.05 Cedar Rail Fence Rails and posts for cedar rail fence shall be of cedar, reasonably straight, machine or hand peeled and branch stubs cut flush.

710.06 Fence Posts and Braces Wood posts shall be of cedar, white oak, or tamarack, of the diameter or section and length shown on the plans.

Round wood posts shall be of seasoned stock straight and sound and shall have been cut from live growing trees with the outer and inner bark removed and all knots trimmed flush with the surface of the post. Rotted, loose or hollow knots, plugged or open holes will not be permitted. Sound knots will be permitted if the diameter of any one knot or the combined diameter of 2 or more knots occurring in the same cross section is not greater than one-third of the circumference of the post at that cross section. Posts shall be of uniform taper from top to bottom not to exceed 40 mm [1½ in] in taper in 2.1 m [7 ft].

The minimum diameter of heartwood in line posts at their small end shall be no less than 75 mm [3 in]. The minimum diameter of line posts at the small end shall be no less than 75 mm [3 in]. The maximum diameter of line posts at the small end shall be 150 mm [6 in]. The minimum diameter of heartwood in end, corner, gate, and barway posts shall be 110 mm [4½ in] at the small end. The minimum diameter of end, corner, gate, and barway posts at the small end shall be 110 [4½ in]. The maximum diameter of end, corner, gate, and barway posts shall be 200 mm [8 in].

That portion of wood posts to be set below ground shall be immersed to a depth of 1200 mm [4 ft] in a tank or barrel containing an approved commercial timber preservative solution for a minimum of 60 minutes. All wood posts so treated, unless otherwise specified by the Resident, shall have been peeled and air seasoned to permit thorough drying for at least 3 months before treatment. After being treated, the posts shall be piled to permit thorough drying before being set in the ground.

Braces shall be of spruce, eastern hemlock, Norway pine, pitch pine, or tamarack timbers or spruce, cedar, or tamarack round posts of sufficient length to make a diagonal brace between adjacent posts. If other than cedar, white oak, or tamarack, braces shall be treated as described above for posts except that they shall be immersed full length.

Metal posts and braces for woven wire fence shall be of new billet steel conforming to the requirements of ASTM A615M/A615 or Commercial Standard 184-51, or shall be rail steel conforming to the requirements of ASTM A616/A616M, or ASTM A499. Posts shall be galvanized according to the requirements of AASHTO M111. Steel pipe used for woven wire fence corner posts, for rails and for bracing shall conform to the requirements of ASTM A53, galvanized.

Metal posts, rails, and bracing for chain link fence shall be as specified in AASHTO M181. Expansion sleeves, turnbuckles and other fittings and hardware shall be galvanized in accordance with the applicable requirements of ASTM A153.

710.07 Guardrail Posts Posts shall be of wood or steel.

- a. Wood posts shall be of cedar, tamarack, white oak, Norway pine, southern yellow pine, pitch pine, Douglas fir, maple, beech, birch, red pine, white pine, eastern hemlock, or red oak. They shall be of well seasoned, straight and sound timber cut from live growing trees, free from loose knots or other structurally weakening defects, including shake, holes and heart rot over 25 mm [1 in] in diameter. The

posts shall be free from season checks that exceed 6 mm [$\frac{1}{4}$ in] in width. A tolerance of 25 mm [1 in] in length and 6 mm [$\frac{1}{4}$ in] in width or thickness is permitted in the dimensions of rectangular posts. They shall be well sawn and have square edges except that wane not more than 38 mm [$1\frac{1}{2}$ in] wide and extending not more than $\frac{1}{2}$ the length of the piece will be allowed on that portion of the post to be placed below ground. Sound, tight, well spaced knots to 64 mm [$2\frac{1}{2}$ in] diameter will be permitted.

Wood posts and offset brackets shall be preservative treated in accordance with the requirements of AASHTO M133 using pentachlorophenol or chromate copper arsenate preservative. Treatment shall be according to the Standards of AWPA C5.

Composite material blocks tested and meeting the requirements of the National Cooperative Research Program Report 350 and approved by the FHWA may be used as offset brackets.

- b. Galvanized steel posts shall conform to the requirements of AASHTO M183/M183M if a rolled section or ASTM A769/A769M Grade 36 if a welded section. Fabrication will be in accordance with Section 504 - Structural Steel. Galvanizing shall be in accordance with AASHTO M111.
- c. Corrosion resistant steel posts shall conform to the requirements of ASTM A769/A769M, Grade 50W if a welded section. Fabrication will be in accordance with Section 504 - Structural Steel.

710.08 Guardrail Hardware Guardrail hardware shall conform to the applicable standards contained in the latest ARTBA Bulletin No. 268B, "A Guide to Standardized Highway Barrier Rail Hardware", approved by the AASHTO-ARTBA-AGC Joint Cooperative Committee, Technical Bulletin Number 268-B.

All galvanized fittings, bolts, washers, twisted end section anchors and other accessories shall be in accordance with the requirements of AASHTO M111, M232 or AASHTO M298, Class 50, Type I, whichever applies. All galvanizing shall be done after fabrication.

Hardware for corrosion resistant guardrail shall be in accordance with ASTM A325M/A325, Type 3, except the 400 mm [16 in] bolts and nuts for attaching the metal beam rail to the posts, which may be galvanized as specified above.

SECTION 711 - MISCELLANEOUS BRIDGE MATERIAL

711.01 Steel Pipe Piles Steel pipe piles shall conform to the requirements of ASTM A252, Grade 2 with either straight or spiral butt-welded seams. Lap welded seams are not acceptable. The steel shall be a Prequalified Base Metal from the AWS D1.1 Structural Welded Code - Steel.

Cast steel points and splices shall conform to the requirements of ASTM A27/A27M Grade 450-240, (Grade 65-35) or ASTM A148/A148M Grade 620-415, (Grade 90-60).

711.02 Gabions Each shipment of gabions to a job site shall be accompanied by a certificate that states that the material conforms to the requirements of this specification. The certificate shall be on manufacturer's letterhead and shall be signed by an officer of the company having legal authority to bind the company.

Mesh openings shall be hexagonal in shape, measuring approximately 75 mm by 100 mm [3 in by 4 in] and shall be uniform in size. Double twist mesh joints shall be flexible with each pair of wires twisted three half turns, commonly called triple twisted, to prevent unraveling. Steel wire and galvanizing shall meet the requirements of ASTM A641M/A641 and ASTM A90, shall have a Class 3 coating, and shall be soft temper. The wire mesh shall have a sufficient elasticity to permit elongation of the mesh equivalent to a minimum of 10% of its length.

a. Galvanized Gabions without Polyvinylchloride Coating The diameter of the steel wire mesh shall be 3 mm [0.1181 in] after galvanizing. The diameter of the selvedge wire, running through all the edges (perimeter wire), shall be 3.899 mm [0.1535 in] after galvanizing. The diameter of the wire for assembling and lacing the gabion units shall be 2.2 mm [0.0866 in] after galvanizing. The above wire sizes shall have a tolerance of +/- 2.5%.

b. Polyvinylchloride (PVC) Coated Gabions When specified on the plans, all galvanized steel wire shall be coated with a minimum of 0.38 mm [0.015 in] of gray or green PVC, which shall be suitable to resist the destructive effects of immersion in acidic, salt, or polluted water, exposure to ultra violet light and abrasion and retain these characteristics after a period of not less than 3,000 hours when tested in accordance with ASTM G23. The diameter of the steel wire mesh shall be 2.70 mm [0.1063 in] after galvanization and 3.46 mm [0.1363 in] overall, core wire plus PVC coating.

The diameter of the selvedge wire running through all the edges (perimeter wire) shall be 3.399 mm [0.1338 in] after galvanizing and 4.161 mm [0.1638 in] overall, core wire plus PVC coating. The diameter of the wire for assembling and lacing the gabion units shall be 2.2 mm [0.0866 in] after galvanizing and 2.962 mm [0.1166 in] overall, core wire plus PVC coating. All wire sizes shall have a tolerance of +/- 2.5%, the thickness of the PVC excluded.

The mesh shall be capable of withstanding the test described below:

An uncut section of mesh 2 m [6 ft] long and of a minimum width of 1 m [3 ft], including all selvedge bindings, shall have the ends securely clamped for 1 m [3 ft] along the width of the sample. When the width of the section under test exceeds 1 m [3 ft], the clamps shall be placed in the middle portion of the width and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to sufficient tension to cause 10% elongation of the sample section between clamps. After elongation and while clamped as

described above (and otherwise unsupported), the section shall be subjected to a load applied to an area of 0.09 m² [1 ft²] located approximately in the center of the sample section between the clamps and in a direction perpendicular to the direction of the tensile force. The sample shall withstand without rupture of any wire or opening of any mesh fastening, an actual load, so applied, equaling or exceeding 2720 kg [6,000 lb]. The ram head used in the test shall be circular with its edges beveled or rounded to prevent cutting the wires.

711.03 Stones for Gabions Stones to fill gabions shall be of clean, hard, and durable rock with a minimum dimension of 100 mm [4 in] in all directions and a maximum dimension of 300 mm [12 in].

Stones to fill hand filled gabions shall be of clean, hard, durable, crushed ledge or quarried rock with a minimum dimension of 100 mm [4 in] in all directions and a maximum of 300 mm [12 in].

711.04 Bridge Drains Bridge drains shall be fabricated in conformance with the details shown in the Contract documents, and to the requirements of Section 504 - Structural Steel. All bridge drain parts shall be hot-dip galvanized in accordance with the requirements of Section 504 - Structural Steel.

711.05 Protective Coating for Concrete Surfaces The coating shall be a blend of 50% by volume boiled linseed oil and 50% petroleum spirits. The linseed oil shall comply with the requirements of ASTM D260. Petroleum spirits shall meet the requirements of ASTM D235. CAUTION: This blend is flammable.

711.06 Stud Shear Connectors, Anchors and Fasteners Shear connectors shall meet the dimensional tolerances of Figure 7.1 of the ANSI/AASHTO/AWS D1.5 Bridge Welding Code (D1.5 Code). Shear connectors, anchors and fasteners shall meet the material requirements of Section 7 of the D1.5 Code. Shear connectors shall meet the mechanical property requirements of Table 7.1, Type B of the D1.5 Code. Anchors and fasteners shall meet the mechanical property requirements of Table 7.1 of the D1.5 Code, Type A.

711.07 Mattresses Each shipment of mattresses on a job site shall be accompanied by a certificate that states that the material conforms to the requirements of this specification. The certificate shall be on the manufacturer's letterhead and shall be signed by an officer of the company having legal authority to bind the company.

Mesh openings shall be hexagonal in shape, measuring approximately 63 mm by 83 mm [2½ in by 3¼ in] and shall be uniform in size. Double twist mesh joints shall be flexible with each pair of wires twisted three half turns (triple twisted) to prevent unraveling. Steel wire and galvanizing shall meet the requirements of ASTM A641M/A641 and ASTM A90, shall have a Class 3 coating, and shall be soft temper. The wire mesh shall have a sufficient elasticity to permit elongation of the mesh equivalent to a minimum of 10% of its length.

a. Galvanized Mattresses without Polyvinylchloride Coating The diameter of the steel wire mesh shall be 2.2 mm [0.0866 in] after galvanizing. The diameter of the

selvedge wire, running through all the edges (perimeter wire), shall be 2.7 mm [0.1063 in] after galvanizing. The diameter of the wire for assembling and lacing the units shall be 2.2 mm [0.0866 in] after galvanizing. The above wire sizes shall have a tolerance of +/- 2.5%.

- b. Polyvinylchloride (PVC) Coated Mattresses When specified on the plans, all galvanized steel wire shall be coated with a minimum thickness of 0.38 mm [0.015 in] of gray or green PVC, which shall be suitable to resist the destructive effects of immersion in acidic, salt or polluted water, exposure to ultra violet light and abrasion and retain these characteristics after a period of not less than 3,000 hours when tested in accordance with ASTM G23. The diameter of the steel wire mesh shall be 2.2 mm [0.0866 in] after galvanization and 2.96 mm [0.1166 in] overall minimum, core wire plus PVC Coating.

The diameter of the selvedge wire running through all the edges (perimeter wire) shall be 2.67 mm [0.1050 in] after galvanizing and an overall minimum diameter of 3.43 mm [0.1350 in], core wire plus PVC coating. The diameter of the wire for assembling and lacing the units shall be 2.2 mm [0.0866 in] after galvanizing and 2.96 mm [0.1166 in] nominal overall, core wire plus PVC coating. All wire sizes shall have a tolerance of +/- 2.5%, the thickness of the PVC excluded.

The mesh shall be capable of withstanding the test described below:

An uncut section of mesh 2 m [6 ft] long and a minimum width of 1 m [3 ft], including all selvedge bindings, shall have the ends securely clamped for 1 m [3 ft] along the width of the sample. When the width of the section under test exceeds 1 m [3 ft], the clamps shall be placed in the middle portion of the width and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to sufficient tension to cause 10% elongation of the sample section between clamps. After elongation and while clamped as described above (and otherwise unsupported), the section shall be subjected to a load applied to an area of 0.09 m² [1 ft²] located approximately in the center of the sample section between the clamps and in a direction perpendicular to the direction of the tensile force. The sample shall be able to withstand without rupture of any wire or opening of any mesh fastening, an actual load, so applied, equaling or exceeding 2720 kg [6,000 lb]. The ram head used in test shall be circular with its edges beveled or rounded to prevent cutting the wires.

711.08 Stones for Mattresses Stones to fill mattresses shall be of clean, hard, and durable rock with a minimum dimension of 75 mm [3 in] in all directions and a maximum dimension of 150 mm [6 in].

711.09 Neoprene Pads The neoprene shall be either chloroprene or natural polyisoprene of 50 +/-5 Shore A durometer hardness and shall conform to the requirements of Division 2, Sections 18.2 and 18.3 of AASHTO Standard Specifications for Highway Bridges, where applicable.

711.10 H-Beam Pile Tips H-beam pile tips shall be cast steel prefabricated pointed H-shaped sections. The slope forming the point shall not be steeper than 1 ¾:1. Material for plain cast steel pile points shall conform to the requirements of ASTM A27/A27M, Grade 450-240 (Grade 65-35). Material conforming to ASTM A148/A148M Grade 620-415 (Grade 90-60) shall be used for pile points equipped with cutting teeth. The use of pile tips fabricated by welding sections of plate in an "H" configuration will not be allowed.

711.11 Elastomer Elastomer for bearings shall be 100% virgin natural rubber (polyisoprene) meeting the physical requirements of Table A, or 100% virgin neoprene (polychloroprene) meeting the physical requirements of Table B. The elastomer compound shall be classified as low-temperature Grade 3. Compounds of nominal hardness between the values shown may be used and the test requirements interpolated. When test specimens are cut from the finished product a 10% variation in "Physical Properties" will be allowed.

Flash tolerance, finish, and appearance shall meet the requirements of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings at RMA F2 for extruded bearings.

TABLE A - REQUIREMENTS FOR NATURAL RUBBER

ASTM STANDARD	PHYSICAL PROPERTIES	50 DURO	60 DURO	70 DURO
D2240	Hardness	50 +/- 5	60 +/- 5	60 +/- 5
D412	Tensile strength, minimum Mpa [psi]	15.5 [2250]	15.5 [2250]	15.5 [2250]
	Ultimate elongation, minimum Percent	450	400	300
	<u>HEAT RESISTANCE</u>			
D573	Change in durometer hardness, maximum Point	+10	+10	+10
70 Hours @ 70°C [158°F]	Change in tensile strength, maximum Percent	-25	-25	-25
	Change in ultimate elongation, maximum Percent	-25	-25	-25
	<u>COMPRESSION SET</u>			
D395 Method B	22 Hours @ 70°C [158°F], maximum Percent	25	25	25
	<u>OZONE</u>			
D1149	25 pphm ozone in air by volume, 20% strain 37.7°C +/- 1°C [100°F +/- 2°F] 48 hours Mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks
	<u>ADHESION</u>			
D429, B	Bond made during vulcanization kg/m [lb/in]	714 [40]	714 [40]	714 [40]
	<u>LOW TEMPERATURE BRITTLENESS</u>			
D746	Grade 3 - Tested @ -40°C [-40°F] Procedure B	No Failure	No Failure	No Failure
	<u>INSTANTANEOUS THERMAL STIFFENING</u>			
D1043	Grade 3 - Tested @ -40°C [-40°F]			

	Stiffness at test temperature shall not exceed 4 Times the stiffness measured at 23°C [74°F]			
Quad Sheer Test as Described in Annex A	<u>LOW TEMPERATURE CRYSTALLIZATION</u> Grade 3 - 14 days @ -26°C [-15°F]			

Stiffness at test time and temperature shall not exceed 4 times the stiffness measured at 23°C [74°F] with no time delay. The stiffness shall be measured with a quad shear test rig in an enclosed freezer unit. The test specimen shall be taken from a randomly selected bearing. A +/- 25% strain cycle shall be used, and a complete cycle of strain shall be applied with a period of 100 seconds. The first 0.75 cycle of strain shall be discarded and the stiffness shall be determined by the slope of the force deflection curve for the next 0.25 cycle of loading.

TABLE B - REQUIREMENTS FOR NEOPRENE

Shall meet the requirement of Table A - Requirements for Natural Rubber, except for the following:

	<u>HEAT RESISTANCE</u>			
D573 70 Hour @ 100°C [212°F]	Change in durometer hardness, maximum Points	+15	+15	+15
	Change in tensile strength, maximum Percent	-15	-15	-15
	Change in ultimate elongation, maximum Percent	-40	-40	-40
	<u>COMPRESSION SET</u>			
D395 Method B	22 Hours @ 100°C [212°F], maximum Percent	35	35	35
	<u>OZONE</u>			
D1149	100 pphm ozone in air by volume, 20% strain 37.7°C +/- 1°C [100°F +/- 2°F], 100 hours Mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks

Stiffness at test time and temperature shall not exceed 4 times the stiffness measured at 23°C [74°F] with no time delay. The stiffness shall be measured with a quad shear test rig in an enclosed freezer unit. The test specimen shall be taken from a randomly selected bearing. A +/- 25% strain cycle shall be used, and a complete cycle of strain shall be applied with a period of 100 seconds. The first 0.75 cycle of strain shall be discarded and the stiffness shall be determined by the slope of the force deflection curve for the next 0.25 cycle of loading.

711.12 Stainless Steel Stainless steel shall conform to the requirements of ASTM A167 Type 308 or ASTM A240, Type 304.

711.13 PTFE The PTFE, filled or unfilled, shall conform to the requirements of Section 18.8 of AASHTO, LRFD Bridge Construction Specifications. PTFE resin shall conform to the requirements of ASTM D4894 or D4895.

SECTION 712 - MISCELLANEOUS HIGHWAY MATERIAL

712.02 Calcium Chloride Calcium chloride shall conform to the requirements of AASHTO M144 (ASTM D98).

712.03 Portland Cement Concrete for Concrete Curb Portland cement concrete shall meet the applicable requirements of Section 502 - Structural Concrete, and shall meet Class A requirements with the following modifications:

- a. Air content shall be 5% to 8%.
- b. Portland cement shall conform to the requirements of AASHTO M85 Designation for Type I, Type II, or Type III.
- c. A minimum 28-day compressive strength of 34.5 MPa [5000 psi] is required.

All curb shall be cast in steel or concrete forms which will produce a satisfactory surface requiring no further finishing, rubbing or patching after the forms are removed, except for the removal of excess material along the edges. No form joint marks shall be visible when the precast curb units are set in place. Curbs with shrinkage cracks will not be accepted.

Steel reinforcement and dowels shall conform to Section 503 - Reinforcing Steel.

Dimensions The precast curb units shall be of the dimensions indicated on the plans and shall be cast in lengths of not less than 1.2 m [4 ft] nor greater than 3 m [10 ft]. Random lengths of curb less than 1.2 m [4 ft] in length may be obtained by sawing regular precast curb, if the Resident determines it necessary to meet field conditions. All curb to be set on a radius of 20 m [50 ft] or less shall be precast to fit the curve as required.

When a depressed or modified section of curb is called for on the plans or ordered by the Resident, for driveways, crossings, closures, transitions or for other reasons, the Contractor shall furnish curbing with the required modifications.

Inlets used at catch basins shall conform to the applicable requirements of Vertical Curb, Type 2 and to the shape, dimensions, and details as shown on the Standard Detail plans.

Curing The units shall be cured either by steam or water for a sufficient length of time for the concrete to obtain the minimum 28day compressive strength of 34.5 MPa [5000 psi].

- a. Steam Curing Two to four hours after the concrete has been placed and attained the initial set, the first application of steam shall be made. Forms shall be removed after the units have been cured for 24 hours. The steam shall be 100% relative humidity to provide moisture for proper hydration of cement. The steam shall be directly applied onto the concrete. During application of steam, the ambient air temperature of 55°C [130°F] is required. When discontinuing the steam application, the ambient temperature shall be decreased at a rate of 22°C [40°F] per hour until a temperature of 11°C [20°F] above the atmospheric temperature has been attained. The concrete shall not be exposed to temperature below freezing for a minimum of 6 days after casting.

b. Water Curing The units may be water cured by covering with water, saturated material, or other acceptable or approved methods that will keep the units moist for a period of 5 days.

712.04 Stone Curbing and Edging Stone for curbing and edging shall be approved granite from acceptable sources. The stone shall be hard and durable, predominantly gray in color, free from seams that impair its structural integrity and of smooth splitting character. Natural grain size and color variations characteristic of the source deposit will be permitted. Such natural variations may include bands or clusters of mineral or both of mineral crystallization that do not impair the structural integrity of the curb stone. The dimensions, shape and other details shall be as shown on the plans.

The exposed face of stone curb shall be free from indications of drill holes. Half drill holes not larger than 20 mm [$\frac{3}{4}$ in] diameter will be permitted in the arris line in the plane of the back.

a. Vertical Curb shall have a top surface sawed or dressed to an approximate true plane with no depression or projection on that surface of over 3 mm [$\frac{1}{8}$ in]. The top front arris line shall be pitched straight and true with no variations from a straight line greater than 6 mm [$\frac{1}{4}$ in]. The top back arris line shall meet the same requirement except that indentations of a maximum of 9 mm [$\frac{3}{8}$ in] will be allowed. There shall be no projection or depression on the back face that would exceed a batter of 1 horizontal on 3 vertical for a distance from the top of 75 mm [3 in].

The front face shall be at right angles to the top and shall be smooth split and have no projections greater than 25 mm [1 in] or depressions greater than 13 mm [$\frac{1}{2}$ in], measured from the vertical plane of the face through the top arris line for a distance down from the top of 200 mm [8 in]. The remainder of the face shall have no projections or depressions greater than 25 mm [1 in] from the plane of the face.

The ends of the curb shall be approximately square with the planes of the top, back and face and so finished that when the sections are placed end to end with the required minimum spacing of 6 mm [$\frac{1}{4}$ in] no more than 16 mm [$\frac{5}{8}$ in] space shall show in the joint for the full width of the top surface and for the entire exposed front face. The remainder of the end may extend back no more than 200 mm [8 in] from the plane of the joint.

Drill holes through the curb will be allowed providing they are at least 225 mm [9 in] below the top and are mortared full with portland cement mortar before placing the stone.

b. Miscellaneous Stone Curb When a depressed or modified section of curb is called for on the plans or ordered by the Resident, for driveways, crossings, closures, transitions or for other reasons, the Contractor shall furnish curbing with the required modifications.

c. Curb Inlets Inlets used at catch basins shall conform to the applicable requirements of Vertical Curb, Type 1 and to the shape, dimensions, and details as shown on the Standard Detail

d. Dimensions The stone curb units shall be of the dimensions indicated on the plans and shall be cut in lengths of not less than 1.2 m [4 ft] nor greater than 3 m [10 ft]. Random lengths of curb less than 1.2 m [4 ft] in length may be obtained if the Resident determines it necessary to meet field conditions. All curb to be set on a radius of 20 m [60 ft] or less shall be cut to fit the curve as required.

e. Vertical Bridge Curb shall conform to the requirements above, except as indicated on the plans and as follows:

1. The back face of the curb stones shall have no projections or depressions greater than 25 mm [1 in], measured from the vertical plane of the back face through the arris or pitch line down to the bottom of the stone. The front face shall be finished as required for Vertical Curb, Type 1, except that it shall be finished the full distance down on the face. Bottoms of curb stones shall be approximately parallel to the top and sawed or dressed to lay with a bedding of approximately 25 mm [1 in] for the full length of the stone.

2. Anchor holes shall be provided in the back of the stones, pitched down as shown on the plan, a maximum of 450 mm [18 in] from each end of the stone and spaced horizontally at a maximum of 1200 mm [4 ft] apart. A minimum of 2 anchor holes shall be provided in each stone.

3. The ends of stones at expansion joints between spans and at ends of the bridge shall be cut to present a vertical face when set in position, beveled to the skew angle, if any and the entire end finished in the same manner as the top.

4. The exposed edges of the stones at intermediate joints shall be trimmed square with the planes of the top and front face so that a neat, parallel joint, free from drill holes is formed between the stones. Length of stones shall be so scheduled that joints will be uniform in width along any run of curb. Joints shall be 13 mm [$\frac{1}{2}$ in], plus or minus 3 mm [$\frac{1}{8}$ in]. A joint shall be provided at each curb and sidewalk contraction joint of the bridge.

5. Stones set transversely at ends of a bridge, when the grade exceeds 2%, shall have the top beveled to fit the grade of the bridge.

6. Mortar for bedding shall be composed of 1 part portland cement and 2 parts sand with sufficient water to form a workable mix. Cement, sand, and water shall conform to Section 502 - Structural Concrete.

7. Mortar for pointing shall be composed of equal parts sand and portland cement with sufficient water to form a workable mix and shall conform to Section 502 - Structural Concrete.

8. Portland cement grout shall be made the same as mortar for pointing, except that consistency shall be such that it will flow readily.

f. Curb Type 5 The exposed face shall be smooth split to an approximate true plane having no projections or depressions which will allow over 25 mm [1 in] to show between a 600 mm [2 ft] straightedge and the face when the straightedge is placed as closely as possible on any part of the face. Half drill holes not more than 75 mm [3 in] in length and 20 mm [$\frac{3}{4}$ in] in diameter will be permitted along the bottom. The arris line, top front shall be straight and true with no variation from a straight line greater than 3 mm [$\frac{1}{8}$ in]. The arris lines at the bottom of the face shall be straight and true so that not over 25 mm [1 in] shall show between the stone and a straightedge for the full length of the stone. The ends shall be square to the length at the face and so finished that when the stones are placed end to end, no space more than 40 mm [$1\frac{1}{2}$ in] will show in the joint for the width of the face.

When Curbing Type 5 is required on a curve, the pieces shall be shaped as described in the table on the Standard Detail plans.

712.05 Preformed Plastic

Type of Material This section covers reflectorized plastic materials performed into rolls or ribbons of various lengths, pliability, and widths suitable for use as reflecting pavement markings on Portland cement concrete or bituminous pavement.

General Characteristics The preformed marking materials shall consist of white or yellow films with pigments selected and blended to provide the appropriate highway colors for traffic markings. Glass or ceramic beads shall be incorporated to provide immediate and continuing retroreflection. The size, quality, and refractive index of the beads shall be such that the performance requirements of this specification shall be met.

The edges of the preformed material shall be clean cut and true. The preformed plastic material may be supplied complete with a precoated, factory applied adhesive for immediate pavement application without the use of heat, solvent, or other types of adhesive for immediate pavement application without the use of heat, solvent, or other types of adhesive operations or it may be furnished with separate adhesives as recommended by the manufacturer.

The affixed material shall be capable of molding itself to the pavement contoured by the action of traffic and maintain its original dimensions and placement under normal traffic conditions at the pavement temperatures, which could occur within the State. After application, the markings shall be immediately ready for traffic.

Physical Requirements - Color Pigments shall be selected and blended to conform to standard highway colors throughout the expected life of the material. When tested by Federal Test Method Standard 141 Method 4232, the white shall be no darker than Color Number 37778 of Federal Standard Number 595 and the yellow shall conform to Color Number 33538 of Federal Standard Number 595 (Highway Yellow Color PR#1).

Retro-Reflectivity The retro-reflective preformed film shall have a layer of reflective spheres bonded to the top surface. The white and yellow film shall have the following initial

minimum retroreflectance values at 0.2° and 0.5° observation angles and 86° entrance angle as measured in accordance with the photometric testing procedures of ASTM D4061.

Retroreflectance values shall be expressed as specific luminance in millicandelas per square meter per lux ($\text{mcdm}^{-2}\text{lx}^{-1}$) [millicandelas per square foot/foot candle ($\text{mcd ft}^{-2}\text{fc}^{-1}$)]

Observation Angle SL[$\text{mcdm}^{-2}\text{lx}^{-1}$] [$\text{mcd ft}^{-2}\text{fc}^{-1}$]	White		Yellow	
	0.2°	0.5°	0.2°	0.5°
	550	380	410	250

The test distance shall be 15 m [50 ft] and the sample size a 600 mm by 750 mm [2 ft by 2½ ft] rectangle. The angular aperture of both the photoreceptor and light projector shall be 10 minutes of arc. The reference center of the sample and the reference axis shall be taken perpendicular to the test sample.

Bead Retention When tested with a 50 mm by 150 mm [2 in by 6 in] sample bent over a 13 mm [½ in] diameter mandrel with the 50 mm [2 in] dimension perpendicular to the mandrel axis, microscopic examination of the arc on the mandrel shall show no more than 10% of the beads are entrapped in the binder and less than 40% of the surface of the bead.

Application The preformed plastic material shall be capable of application to non-defective pavement surfaces that are dry and free from dirt or other foreign matter. For normal application, the pavement temperature should be at least 15°C [60°F] and rising.

Special instructions should be supplied by the vendor for application to be made at pavement temperatures below 15°C [60°F]. Application shall be according to manufacturer's recommended procedures. Plastic pavement marking materials shall only be applied to surfaces with temperatures within the range specified by the manufacturer for optimum adhesion.

Adhesive, activators or special coatings for various types of pavement surfaces shall be provided with the preformed plastic material. Detailed information must be supplied with the material outlining required application procedures for such adhesives, activators, or special coating.

Preformed plastics shall be capable of being applied to new asphalt pavement immediately prior to the final rolling of the new surface and of being rolled into place with conventional pavement and highway rollers. The plastic material and adhesives used in such applications shall be of the type that water used on the roller to prevent asphalt pickup shall not be harmful to the successful application of the plastic.

Special equipment necessary for the successful installation of any preformed plastic material shall be available from the manufacturer of the plastic material on a lease, loan, or purchase basis.

Longitudinal lines shall be offset at least 50 mm [2 in] from construction joints of portland cement concrete pavement. When directed by the Resident, opening of 150 mm [6 in] lengths shall be left at 6 m [20 ft] intervals in edge lines not inlaid into the pavement surface that are placed on the inside of superelevated curves so as to prevent the ponding of water on the pavement surface.

712.06 Precast Concrete Units. Precast concrete units shall conform to the plan dimensions and shall meet the requirements of ASTM C478M (ASTM C478) except as modified below.

GRACE Structural Fibers or an approved equal may be used as a replacement of 6 x 6 #10 gauge welded wire fabric when used at dosage rates of 4.5 kg/m³ [7.5 lb/yd³] for the construction of manholes and catch basins. The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

Cement shall conform to Section 701. An approved air-entraining admixture shall be added to obtain the required air content.

Aggregates shall meet the quality requirements of Section 703.01 - Fine Aggregate for Concrete and Section 703.02 - Coarse Aggregate for Concrete except that limitations on grading and the fineness modulus may be omitted.

The concrete mix design shall be approved by the Department. Concrete shall contain 6% air content, plus or minus 1½% tolerance. All concrete shall develop a minimum compressive strength of 20 MPa [3000 psi] in 7 days or 28 MPa [4000 psi] in 28 days.

712.061 Structural Precast Concrete Units Structural precast concrete units shall conform with the dimensions shown on the plans, the requirements of this Specification and with the approved shop drawings.

Materials Materials for concrete shall conform to the requirements of Section 502.03 - Materials. Cement shall be Type I, Type II, or Type III. Coarse aggregate gradation shall comply with Section 703.02 - Coarse Aggregate for Concrete, Class A or AA or Latex. The maximum water cement ratio shall be 0.40. The minimum air content shall be 5.5%. Concrete shall contain a minimum of 15 L/m³ [3 gal/yd³] of calcium nitrite solution or equivalent corrosion inhibitor approved by the Resident. The minimum 28 day concrete compressive strength shall be 35 MPa [5000 psi] unless otherwise stated on the plans. Concrete shall be controlled, mixed, and handled as specified in Section 502.

Material for reinforcing shall meet the requirements of Section 709.01 - Reinforcing Steel or Section 709.02 - Welded Steel Wire Fabric.

Quality Control and Quality Assurance Quality Control (QC) is the responsibility of the Contractor. The Quality Control Inspector (QCI) shall inspect all aspects of the work. Acceptance is the prerogative of the Resident. The Department's will ensure that the Contractor's QC is performing properly, verify documentation, periodically inspect workmanship and witness testing. Testing deemed necessary by the Resident in addition to

the minimum testing requirements shall be scheduled to minimize interference with the production schedule.

The Contractor shall provide a private office at the casting plant for the Inspector. The office shall have an area not less than 9.3 m² [100 ft²] and shall be conveniently located to the work. The office shall be climate controlled to maintain the temperature between 18°C [64°F] and 30°C [86°F], lighted and have the exit(s) closed by a door(s) equipped with a lock and 2 keys which shall be furnished to the Inspector(s). The office shall be equipped with a desk or table having a minimum size of 1200 mm by 760 mm [4 ft by 2½ ft], 2 chairs, a telephone, a plan rack and a 2-drawer letter size file cabinet with a lock and 2 keys which shall be furnished to the Inspector(s).

The facilities and all furnishings shall remain the property of the Contractor upon completion of the work. Payment for the facilities, its' heating and lighting, telephone installation, basic monthly telephone charges and all furnishings shall be incidental to the contract.

Construction The Contractor shall notify the Resident at least five working days prior to production of the precast units. The precast units shall be manufactured at a facility that has had a minimum of five years experience in producing similar type products. The plant shall meet the requirements of AASHTO M-157.

Reinforcing steel shall be fabricated, handled, and placed in accordance with Section 503 - Reinforcing Steel. Reinforcing shall be as shown on the approved shop drawings. Clearance shall be 50 mm by 12 mm [2 in by ½ in]. If reinforcing steel is not noted on the plans or drawings, the minimum amount of steel required shall be the area of steel equal to a grid of #13 bars spaced at 450 mm [No. 4 bars at 18 in] in both directions, horizontally and vertically. Only one mat of steel is required for concrete thickness of 175 mm [7 in] or less; two mats, one each face is required for thickness greater than 175 mm [7 in].

All concrete shall be cast and consolidated in forms that will produce dense concrete with surfaces that are free of voids, stone pockets, or other irregularities. Forms shall be sufficiently rigid and accurate to maintain the member's dimensions.

The units shall be cured until design (28 day) strength is attained by one of the following methods:

a. Accelerated Curing Accelerated cure requires that concrete cure temperature attain a minimum of 50°C [120°F] and kept at this temperature for at least 8 hours. This may be accomplished with radiant heat or steam. The maximum heat rate gain during curing or the heat rate loss after accelerated curing is discontinued shall be 20°C/hour [36°F/hr].

Accelerated cure shall begin 2 to 4 hours after the concrete has been placed and has attained its initial set. The minimum concrete temperature before application of heat is

10°C [50°F]; the maximum enclosure temperature shall be 80°C [176°F]. Temperatures shall be monitored during cure with recording thermometers.

Steam curing shall be under an enclosure to retain the live steam to minimize moisture and heat loss. Provisions shall be made to prevent surface drying until steam application begins. Steam shall saturate the enclosure to provide moisture for proper hydration of cement. The steam shall not be applied directly onto the concrete. When radiant heat is used, provisions shall be made to ensure excess water moisture is available to prevent drying of the surfaces.

Curing shall continue, after the application of the heat ceases, until design strength is attained; preference shall be given to moist curing. The minimum curing temperature shall be 10°C [50°F]. Further curing to attain design strength will not be required if a minimum of 80% of the design strength has been attained with accelerated cure.

b. Water Curing The units may be cured by covering with a water saturated material or other acceptable method(s) that will keep the units moist for a minimum of 5 days.

c. Other methods of curing, such as “membrane curing compound” or “moisture retention without heat”, may be used if approved by the Resident and performed in accordance with manufacturer’s recommendations or agreed upon procedures.

The forms shall remain in place until the concrete attains a minimum compressive strength of 21 MPa [3000 psi] and until they can be removed without damaging the member. When curing method b or c is used: the concrete shall not be exposed to below freezing temperatures for a minimum of six days after casting when Type I or II cement is used or a minimum of three days when Type III cement is used.

Acceptance of structural precast units, for each day’s production, will be determined, based on compliance with this specification and satisfactory results of concrete testing and process control test cylinders made and tested in accordance with the following standards:

AASHTO T23 (ASTM C31/C31M) Practice for Making and Curing Concrete Test Specimens in Field

AASHTO T22 (ASTM C39) Test Method for Compressive Strength of Cylindrical Concrete Specimens

AASHTO T119 (ASTM C143) Test Method for Slump of Hydraulic Cement Concrete

AASHTO T141 (ASTM C172) Practice for Sampling Freshly Mixed Concrete

AASHTO T152 (ASTM C231) Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C1064 Test Method for Temperature of Freshly mixed Portland Cement Concrete

A minimum of 8 concrete test cylinders shall be cast to represent each continuous concrete placement. 6 of the cylinders from each test shall be cured under the same

conditions as the units. Unit identification, entrained air content, water-cement ratio, slump, and temperature of the sampled concrete shall be recorded at the time of cylinder casting. All testing shall be done in the presence of the QAI. The QAI will designate the loads to be tested.

At least once a week, the Contractor shall make 4 cylinders for use by the Department. They shall be cured in accordance with AASHTO T23 (ASTM C31/C31M).

All persons performing sampling and/or testing shall hold a current certification issued by ACI or Maine Concrete Technician Certification Board or another equivalent certification.

Manufacture of the units will include all testing described within this specification and in referenced Sections.

Repairs Exposed surfaces shall be of uniform appearance; only minor repairs to remove and blend fins, patch minor spalls and to repair small, entrapped air pockets shall be permitted. Units that are cracked or require surface repairs larger than 1250 mm² [2 in²] or an accumulated repair area greater than 10% of the surface being repaired may be rejected.

Tolerances Dimensional tolerances shall be in conformance with the applicable reference specification or the established industry standards for the product being produced.

Documentation The producer of the structural precast units shall keep accurate records of aggregate gradations, concrete batching, testing, curing, and inspection activities to verify that forms, reinforcing and unit dimensions conform to these requirements. Copies of reports shall be furnished to the Resident when requested.

Marking The date of manufacture, the production lot number, and the type of unit shall be clearly and indelibly scribed on a rear, unexposed portion of each unit.

Handling, Storage and Shipping All units shall be handled, stored, and shipped in such a manner as to eliminate the danger of chipping, cracks, fracture, and excessive bending stresses. Any units found damaged upon delivery, or damaged after delivery, shall be subject to rejection.

SECTION 713 - STRUCTURAL STEEL AND RELATED MATERIAL

713.01 Structural Steel Highway bridge steel shall meet the requirements of AASHTO M 270M/ M 270 (ASTM A 709/ A 709M). The grade of steel shall be as specified on the plans.

Main load-carrying components subject to tensile stresses or stress reversal shall meet the notch toughness requirements in AASHTO M 270M/ M270, Supplementary Requirement S5, Table 9, Zone 2, for non-fracture critical steel or S6, Table 10, Zone 2 for fracture critical steel, (ASTM A 709/A 709M, S83 or S84 TABLE S1.2 or S1.3, Zone 2). Frequency of tension tests

shall comply with the requirements of S1. Fracture critical material shall also comply with the supplementary requirements of S7 and S9

Impact test sampling and testing procedures shall be in accordance with AASHTO T 243M/ T 243 (ASTM A 673/A 673M).

Steel for ancillary bridge products and steel structures shall conform to AASHTO M 270M/ M 270 (ASTM A 709/A 709M) or one or more of the following:

- ASTM A 36/A 36M
- ASTM A 572/A 572M
- ASTM A 588/A 588M
- ASTM A 53
- ASTM A 500
- ASTM A 595 Grade C
- ASTM A 786/A 786M
- ASTM A 847
- ASTM A 992/992M

Ancillary bridge products shall be as described below:

- (a) bearings
- (b) drainage components
- (c) expansion devices (gland seal, compression seal, finger joint)
- (d) modular expansion devices
- (e) steel bridge rail
- (f) catwalks and inspection walkways

713.02 High Strength Bolts Bolts shall conform to the requirements of AASHTO M164M/ M164 (ASTM A325M/A325), Type 1 or Type 3. Type 3 bolts shall be supplied for all structures utilizing unpainted AASHTO M270M/M270 (ASTM A709/A709M) weathering steel.

Nuts shall meet the requirements of AASHTO M291M/M291 (ASTM A563M/A563) or AASHTO M292M/M292 (ASTM A194M/A194).

Circular and beveled washers shall conform to the requirements of AASHTO M293M/M293 (ASTM F436/F436M).

Direct Tension Indicators (DTI'S) shall conform to the requirements of ASTM F959/F959M. DTI's for use with painted steel shall have a plain "as fabricated" finish. DTI's for use with unpainted steel shall be galvanized to the requirements of AASHTO M298 (ASTM B695 Class 50, Type I) and have a fusion-bonded epoxy coating. DTI's used with galvanized steel, metalized steel and steel coated with a zinc-rich primer shall be galvanized to the requirements of AASHTO M298 (ASTM B695 Class 50, Type I).

“Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies shall meet the requirements of ASTM F1852. They shall meet the chemical and mechanical requirements of AASHTO M164M/M164 (ASTM A325/A325M).

Bolts, nuts and washers specified to be galvanized may be galvanized by either hot dip galvanizing to the requirements of AASHTO M232M/M232 (ASTM A153/A153M) Class C or mechanically galvanized to the requirements of AASHTO M298 (ASTM B695), Class 50, Type I).

All fastener (bolts and nuts), whether black or galvanized, shall be coated with a suitable lubricant. Galvanized nuts shall be lubricated with a lubricant containing a visible dye.

Each lot of bolts, nuts, washers and DTI’s shall be tested by the manufacturer in accordance with the tests tabulated in Table 1 - Test Schedule. The testing frequency for bolts, nuts and washers from each shipping lot of fasteners shall be as specified in the applicable AASHTO/ASTM Standard Specifications. The testing frequency for each production lot of DTI’s shall be as specified in ASTM F959/F959M.

TABLE 1 - TEST SCHEDULE*

Bolts	Tensile Strength (Wedge Test)	ASTM F606/F606M
	Proof Load	ASTM F606/F606M
	Hardness	ASTM F606/F606M
	Coating Thickness	ASTM A153/A153M, ASTM B695
Nuts	Proof Load	ASTM F606/F606M
	Hardness	ASTM F606/F606M
	Coating Thickness	ASTM A153/A153M, ASTM B695
Washers	Hardness	ASTM F606/F606M
	Coating Thickness	ASTM A153/A153M, ASTM B695
DTI’s	Coating Thickness	ASTM B695
	Compression Load	ASTM F959

*The supplier(s) shall submit test reports for all testing required in this Table. Test reports shall contain, in addition to the test results, the name and address of the testing agency, the manufacturer, lot tested, and Mill Test Reports for all steel used in the manufacture of the fastener assemblies and DTI’s.

The supplier shall perform, or cause to be performed a Rotational Capacity Test (RCT) for every production lot combination of bolts, washers and nuts. Each combination shall be designated with a unique RCT lot number. The test results shall be furnished to the Engineer.

713.03 Preformed Pads Preformed pads shall be made with new unvulcanized rubber and unused fabric fibers and shall be approximately 3 mm [$\frac{1}{8}$ in] thick after compression and vulcanizing with a proportion of fiber content sufficient to maintain strength and stability. The surface hardness shall be 85 to 95 Shore A Durometer. The ultimate breakdown limit of the pad under compressive loading shall be no less than 70 MPa [10,000 psi].

713.04 Bronze or Copper-Alloy Bearing and Expansion Plates Bronze bearing and expansion plates shall conform to the requirements of AASHTO M107 (ASTM B22), Alloy No.

911 and copper alloy bearing and expansion plates shall conform to the requirements of AASHTO M108, (ASTM B100) Alloy No. 510 or 511, unless otherwise specified. The bearing surface(s) subject to sliding action shall be provided with trepanned recesses (not grooves) filled with a lubricating compound. The lubricating compound shall consist of graphite and metallic substances with a lubricating binder capable of withstanding the atmospheric elements. The compound shall be pressed into the recesses to form dense, non-plastic lubricating inserts.

The lubricating area shall comprise between 25% and 35% of the total area of the plate subject to sliding action. The sliding surface(s) shall be planed parallel to the prevailing direction of movement of the structure and subsequently polished, unless detailed otherwise.

713.05 Cold-finished Carbon Steel Shafting Cold-finished carbon steel shafting shall conform to the requirements of AASHTO M169 (ASTM A108). Grade Designation 1021-1030 inclusive, cold drawn, either semi-killed or fully-killed, shall be furnished unless otherwise specified.

713.06 Castings Gray iron castings shall conform to the requirements of AASHTO M105. Class Number 30 shall be furnished unless otherwise specified.

Malleable iron castings shall conform to the requirements of ASTM A47M/A47. Grade Number 22010 [Number 32510] shall be furnished unless otherwise specified.

Steel castings shall conform to Standard Specification for Steel Castings for Highway Bridges, AASHTO M192/M192M or mild-to-Medium Strength Carbon-Steel Castings for General Applications AASHTO M103/M103M (ASTM A27/A27M). The class 70 or grade 485 - 250 [70 - 36] of steel, respectively, shall be used unless otherwise specified.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect.

All castings must be sand blasted or otherwise effectively cleaned of scale and sand to present a smooth, clean, and uniform surface.

713.07 Metal Bin Type Retaining Wall The metal for bin type retaining wall members shall be galvanized and shall conform to the applicable requirements of AASHTO M36/M36M.

When fiberglass, aramid or carbon graphite fiber coating is specified, the galvanized metal sheets used to form the retaining wall, except the base plates and connecting channels, shall additionally be coated on both sides with a layer of fiberglass, aramid or carbon graphite fibers applied in sheet form by pressing it into the molten spelter. Immediately after the metallic bond has solidified the fibers shall be thoroughly saturated with a bituminous saturant conforming to the following requirements:

Penetration at 25°C [77 °F], 100g [3.5 oz], 5 sec.	3.5 - 4.5 mm [0.14 - .018 in]
Loss on heating at 163°C [325°F], 50g [1.75 oz], 5hrs	Not more than 1.5%
Flash point (open cup)	Not less than 226°C [440°F]
Penetration at 25°C [77 °F], 100g [3.5 oz], 5 sec., of residue after heating at 163°C [325°F], as compared with penetration of asphalt before heating	Not less than 70%
Insoluble in carbon disulfide	Not more than 2%

Testing shall be in accordance with methods specified in AASHTO M20.

Whenever possible in the manufacture of the units, a minimum forming radius of 25 mm [1 in] is to be maintained. All units that are formed with less than 25 mm [1 in] radius shall be hot-dipped galvanized after forming.

Bolts shall conform to the requirements of ASTM F568 Class 4.6 (ASTM A307) and galvanized in accordance with ASTM A153.

713.08 Steel Extrusions Material for steel extrusions for expansion devices shall be ASTM A36/A36M, ASTM A588/A588M, or ASTM A242/A242M, except that ASTM A242/A242M shall not be used for extrusions that are to be welded.

SECTION 714 - JOINT SEALS

714.01 Elastomer for Seal Elements The preformed elastomeric polychloroprene joint seal elements, both compression and gland type, shall conform to the requirements of AASHTO M297 (ASTM D3542).

714.02 Fabric for Seal Elements Fabric used for reinforcement in a seal element shall be a non-wicking fabric conforming to the requirement of ASTM D578.

714.03 Lubricant Adhesive The lubricant-adhesive shall be a 1 part, moisture curing, polyurethane and aromatic hydrocarbon solvent mixture and shall have the following physical properties:

Solids content	60-80% by weight
Service Range	-15°C [5°F] to 49°C [120°F] minimum
Film Strength (ASTM D412)	8.3 MPa [1200 psi] minimum
Elongation at Break	250% minimum

Each lot of lubricant-adhesive shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture. Maximum shelf life shall not exceed 6 months.

714.04 Sealant The sealant shall be a one part, moisture curing, polyurethane base, non-sag, elastomeric product, conforming to the requirements of Federal Specification TT-S-0023OC(2), Type II, Class A or ASTM C920, Type S, Grade NS, Class 25.

Each lot of sealant shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture. Maximum shelf life shall be as recommended by the manufacturer.

714.05 Compression Seals Compression seals shall be multi-channel extruded shapes made of material conforming to the requirements of Section 714.01 - Elastomer for Seal Elements, and in a configuration as determined by each particular manufacturer and as shown in the contract documents. The seal shall be marked on the top surface with the manufacturer's name or trademark, the lot number and the size designation at intervals of 1.5 m [5 ft] or less. Actual seal dimensions shall not differ from the nominal dimensions by more than 2 mm per 25 mm [$1/16$ inch/in] of depth or width, or a maximum of 6 mm [$1/4$ in] whichever is less.

The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

714.06 Gland Type Seals Gland type seals shall be single membrane extruded or molded shapes, made of material conforming to the requirements of Section 714.01 - Elastomer for Seal Elements and of a configuration as determined by each manufacturer and as shown in the contract documents. The seals shall be marked on the top surface with the manufacturer's name or trademark, the lot number and the size designation at intervals of 1.5 m [5 ft] or less. If fabric is used to reinforce the seal, it shall conform to the requirements of Section 714.02 - Fabric for Seal Elements.

The material used shall be one of the products listed on the Maine Department of Transportation's Approved Product List.

SECTION 715 - LIGHTING MATERIAL

715.02 Steel Conduit Galvanized steel conduit shall be of uniform thickness with scale-free, smooth circular bore to permit cutting of clean, true threads.

Steel conduit and couplings shall be Schedule 40 galvanized steel pipe conforming to the requirements of ASTM A53. Threaded couplings shall be conduit type permitting the end of conduits to fully abut each other squarely within the coupling. Other fittings for metal conduit, exclusive of bushings shall be threaded malleable iron conforming to the requirements of ASTM A338 and shall be galvanized in accordance with the requirements of ASTM A153.

All bushings shall be threaded, insulated grounding type.

715.03 Non-Metallic Conduit Non-metallic conduit shall be rigid unplasticized polyvinylchloride conduit, suitable for Type II or Type III installations, whichever is required and shall conform to the standards of the NEMA or the UL.

715.04 Prewired Conduit The prewired conduit shall be a unit assembly consisting of the required insulated conductors and neutrals enclosed in a medium or high-density polyethylene duct. The conduit shall be flexible enough for easy coiling or uncoiling at -10°C [15°F]. The duct shall be extruded directly over the paralleled conductors at the factory.

The percent of conduit fill shall be in accordance with the NEC and the UL.

a. Scope: Polyethylene plastic pipe in either medium density or high-density grade, in sizes 19 mm [¾ in] through 63 mm [2½ in] for direct earth burial.

b. Materials:

1. Medium density polyethylene shall meet the applicable requirements as defined in ASTM D1248-70a, Type II, Class C, Category 5 Grade P23.
2. High density polyethylene shall meet the applicable requirements as defined in ASTM D1248-70a, Type III, Class C, Category 5 Grade P34.
3. In addition, the above materials shall meet the requirements as shown below:

<u>Property</u>	<u>Medium Density</u>	<u>High Density</u>	<u>Test Method</u>
Tensile Strength, Minimum MPa [psi]	17.2[2500]	19.3[2800]	ASTM D638M
Elongation, Minimum%	400	400	ASTM D638
Melt Index, Maximum	0.4	0.4	ASTM D1238
Brittle Temperature			
80% Non-failure	-76°C [-105°F]		ASTM D746
Environmental Stress Cracks Resistance, Maximum Failures Per 10 Specimens after 48 Hrs.	2	2	ASTM D1693

The duct shall have dimensions consistent with iron pipe size Schedule 40 conduit. The prewired conduit shall be shipped in continuous lengths on suitable reels.

The wires shall be stranded soft drawn coated copper conductors individually insulated with class THW insulation rated at 75°C [167°F], wet or dry. Insulation thickness shall be 600 volt rated. Phase identification shall be accomplished by numerical coding. Duct size and wire size shall be as indicated on the plans. The wire shall be UL approved.

Terminal connections, splices, and test data requirements shall be as specified in Section 715.07 - Secondary Wiring.

715.05 Metallic Junction and Fuse Box Surface-mounted junction boxes and fuse boxes shall be of either hot-dipped galvanized cast iron or cast aluminum with hinged screw down covers.

Cast iron boxes shall conform to the requirements of Gray and Malleable Iron Castings, Section 713.06. Cast aluminum boxes shall conform to ASTM B108 or ASTM B26/B26M Alloy 356.0.

All boxes shall be furnished with mounting lugs of adequate sizes and threaded bosses properly located and of sufficient thickness to provide a minimum of five full threads for all sizes of conduit used.

Fuse boxes shall be furnished with 5-ampere, cartridge type midget fuses, 10.3 mm [$13/32$ in] in diameter and 38 mm [$1\frac{1}{2}$ in] long with 600 volt fuse holder, unless indicated otherwise on the plans. Fuse boxes shall be bossed for fuse holder mounting.

715.07 Secondary Wiring Secondary wiring cables, including neutrals and grounding conductors, shall be 600 volt cables and shall consist of single conductor, stranded, soft-drawn or annealed copper wire, insulated with flame retardant, moisture and heat resistant thermoplastic material. The cable shall be UL approved and listed as THW.

Wire shall be of sufficient size to allow a maximum voltage drop of 5% from source of power to the most remote luminaire. Phase identification shall be made by factory-applied color coding.

Terminal lugs shall be cast copper alloy, solderless, mechanical type.

All conduit connections in above ground junction boxes and light standards shall be made by connector kits, fused or nonfused, as indicated on the plans. Splices for the roadway lighting shall be made by straight through or wye connector kits as required. Where these connector kits cannot be used as verified by the Resident, connections on cables in junction boxes shall be made by splicing as described elsewhere. The connector kits shall be a quick disconnect type. Double connector kits shall be used where there is more than one phase conductor.

Fused "wye" connectors shall be composed of a "wye" line side housing assembled with a load side and fuse terminal housing. The housing shall be formed from water-resistant synthetic rubber. Each housing shall provide a water seal around the cables and when fully assembled shall form a watertight connector.

The interior shall be arranged to receive and retain line side wiring and the fuse contacts. The fuse contacts shall be spring-loaded copper designated for 30 amperes, 600 volts, shall have 90% minimum conductivity and shall be suitable for gripping 5 amperes or as designated on the plans, 600 volt cartridge type midget fuse approximately 10.3 mm [$13/32$ in] in diameter and 38 mm [$1\frac{1}{2}$ in] long. The contacts shall be fully annealed. The load side conductors shall be connected by crimping and the line side conductors shall be connected with screws. The

connector shall be of the non-locking type that will break off under extreme tensile stress leaving no exposed metal contacts on the line side of the connector.

The cable diameter used will determine the size of each housing. The load side housing shall retain the fuse when disconnected.

Non-fused connectors shall be similar to the fused "wye" connectors. The cable diameter will determine the size of each housing of each connector.

Fuses for connectors shall be rated at 5 amperes or as indicated on the plans.

Underground splices shall be made with cast epoxy splice kits.

715.08 Luminaire, Lamp and Ballast The luminaire shall be designed for the wattage rating and voltage indicated on the plans and for operating on a multiple circuit, using the type of lamps indicated on the plans. All luminaires shall be new and be the product of the same manufacturer.

The luminaire shall be constructed of an aluminum housing and refractor-holder, a refractor-holder latch on the street side and hinge with safety catch on the house side of the luminaire, and a detachable reflector with heat resisting gasketing between the reflector and the socket entry. Luminaires shall mount by a universal slipfitter, which shall clamp onto at least 150 mm [6 in] of a 32 mm to 57 mm [1¼ in to 2¼ in] bracket.

The refractor shall be made of aluminum and finished with prismatic acrylic. For the cutoff optics, a flat glass lens shall be standard except for a dropped clear lexan polycarbonate resin globe for improving the cutoff performance.

Light distribution shall be as shown on the plans and shall conform to ANSI or IES type as specified.

The luminaire shall be supplied with a power factor ballast, of the lag-type regulator capable of operating from a multiple circuit as indicated on the plans. The ballast shall maintain lamp wattage to 6.8% regulation with 1% change in primary voltage variation. Ballast shall provide satisfactory lamp starting and operation to -29°C [-20°F]. The ballast shall be prewired to the lamp socket and terminal board, requiring only connection of the power-supply leads to the ballast primary terminals. The minimum efficiency of the ballast shall be not less than 60%; the power factor not less than 90%.

Lamps shall be of the type and wattage rating indicated below. Lamps used shall conform to the lamp designations as listed in the latest edition of the IES Lighting Handbook.

<u>ANSI & MFG.</u> ANSI	<u>LAMP DESIG.</u> MFG.	<u>WATTAGE</u>	<u>BALLAST #</u>	<u>LUMENS</u>	<u>LAMP LIFE(HR)</u>
S68MS-50	LU50 C50S68	50	S68	4000	24000
S62ME-70	LU70 C70S62	70	S62	6000	24000
S54SB-100	LU100 C100S54	100	S54	9500	24000
S55SC-150	LU150/55 C150S55	150	S55	16000	24000
S50VA-250/S	LU250S C250S50/S	250	S50	30000	24000
S52XB-1000	LU1000 C1000S52	1000	S52	140000	24000

The Contractor shall submit shop drawings of the luminaires, lamps, and ballast data.

Underpass or under check luminaires shall be constructed such that the refractor is hinged and can be opened for maintenance. The beam angles shall be field adjustable for, but not limited to, 60° and 70° settings. The ballast shall be integrally mounted, regulator or constant wattage type and designed to operate from a 3 wire 240/480 volt circuit or voltage indicated on the plans.

Pole top luminaires shall be of colonial or traditional design, shall consist of cast aluminum and slipfitter for 75 mm [3 in] outside the diameter of the pole top, and aluminum side posts that are gasketed to the translucent white acrylic lens panels and cast aluminum top housing. The canopy shall be hinged to the lower housing, held closed with two captive screws and gasketed to the lens. In addition, the internal reflector/ refractor assembly shall be gasketed. The ballast shall be prewired to the terminal socket. The luminaire shall be factory painted black.

715.09 Luminaire, Lamp and Ballast for High Mast Lighting The luminaire and ballast shall be designed for the wattage rating and type of lamp shown on the plans.

The maximum weight of the luminaire shall be 48 kg [105 lb] and its projected area shall not exceed 0.29 m² [3.1 ft²].

The luminaire shall be open ventilated design with an optical system consisting of an aluminum reflector. The reflector shall have a smooth, non-porous inner surface and shall be readily attached to the ballast assembly by means of a captive stainless steel nut and machine screw.

The reflector with its aluminum cover shall be firmly attached to a cast ring. This ring shall have keyhole slots in its upper surface such that the reflector/refractor assembly may be readily attached to or detached from the luminaire bracket entry and lamp support assembly without completely removing the support bolts.

The luminaire ballast shall be enclosed within a Number 356 alloy cast aluminum housing which integrally attaches to the luminaire bracket entry and lamp support assembly. It shall be readily removable without removing the luminaire from the bracket arm.

The luminaire shall be attached to the bracket arm by a bracket entry and lamp support assembly. The base for this assembly shall be cast aluminum. The assembly shall include a side entry slipfitter designed for 50 mm [2 in] pipe with provision for +/- 3° adjustment for leveling the luminaire. The lamp shall be vertical burning and prevented from undue vibration and backing out by means of a stainless steel lamp clamp attached to the assembly but separate from the socket. An enclosed terminal block shall be included such that all electrical connections shall be removed from exposure to weather. A stainless steel or aluminum rolled rain shield shall be attached to the outside of this assembly.

All cast aluminum parts of the luminaire shall conform to ASTM B26/B26M or ASTM B108, Alloy 356.0.

The luminaire shall provide ANSI-IES Type I, Type IV, or Type V distributions.

715.10 Photo Electric Control The control shall meet the following minimum requirements:

a. Unit Design The photoelectric unit shall consist of a light sensitive element connected directly to a control relay without intermediate amplifications. The unit shall be zenith sensing type.

b. Housing The photoelectric control shall be housed in a weatherproof housing.

c. Operating Levels The operating levels shall be factory set to turn on at approximately 20 lx [2.0 foot candles] and off at approximately 65 lx [6.0 foot candles].

d. Supply Voltage The control shall be capable of operation on a supply voltage of 105 to 285 volts.

e. Base The base of the unit shall be provided with a 3-prong, EEI-NEMA standard twist lock plug mounting.

f. Directional Design The control shall be oriented in a northerly direction according to the manufacturer's recommendation.

g. Surge Protection The unit shall have a built-in surge protective device for protection from induced high voltage and follow through currents.

715.11 Service Equipment The service pole or service rack and other entrance equipment shall be as detailed on the plans.

The control cabinet shall be fabricated from cast aluminum, sheet aluminum, galvanized steel, or stainless steel. The following are required:

- a. Hinged cover with weather protected hasp for padlocking. The lock will be provided by others.
- b. Mounting brackets.
- c. Suitable bossed and threaded holes in the case wall for conduit installation.
- d. Independent single pole magnetic trip circuit breakers.
- e. Manual control switch.
- f. Lightning arresters in load and line side - rated 650 Volts RMS, indoor type.
- g. Contactor - One double pole, single throw mercury solenoid contactor with contacts rated at the voltage and amperes shown on the plans. The coil shall be capable of operating at the voltage shown on the plans, 60 hertz. The contactor shall be normally open unless otherwise specified. The contacts shall be mercury.
- h. Ground rods shall be copperclad steel or galvanized, 16 mm [$\frac{5}{8}$ in] diameter, 2.4 m [8 ft] long, complete with ground clamp and square head bolt.

Dry-Type transformers shall be designed for indoor and outdoor installation. The following are required:

- a. 25 KVA rating, 120/240 volt primary, 240/480 volt secondary, single phase 3 wire system, if single phase service is supplied.
- b. Frequency - 60 hertz.
- c. Key-hole mounting slots and lifting groove.
- d. Insulation system for 115°C [239°F] rise at 40°C [104°F] ambient.
- e. Wiring compartment located on bottom front of unit. Access through a single cover.
- f. Heat barrier to protect connecting cables.
- g. Connecting leads to extend 150 mm [6 in] from box and identified with metal tags.
- h. Core and coils to be contained within a non-ventilated weatherproof enclosure.

- i. Conduit knockouts to be located on bottom, back and sides of wiring compartment.
- j. Maximum sound level to be 40 decibels.

Rack-mounted circuit breakers shall be enclosed in NEMA 3R enclosures with rain-tight hubs. The breakers shall be rated for 3 pole, 125 amperes, 600 volt, 4 wire service. Lugs for padlocking shall be supplied.

The service entrance rack shall be constructed as shown on the plan. Minor modifications will be permitted, if approved by the Resident to accommodate variations in equipment dimensions. Lumber shall be as shown on the plan. Bolts and hardware shall be hot-dipped galvanized steel.

715.12 Lowering System for High Mast Lighting Each pole shall be furnished with a mechanical lowering system operated by cables and an electrically operated winch that will permit servicing of the luminaires and associated electrical and mechanical apparatus from the ground. Lowering systems shall permit lowering of the complete assembly, including luminaires, ballasts, fuses, and other apparatus, which may require periodic inspection or servicing, to a height of 1.5 m [5 ft] or less above the pole base plate.

At the top of the pole shaft there shall be mounted a detachable head assembly which remains fixed in position during the raising and lowering operation. The head assembly shall consist of 3 or more symmetrically located fixed support arms, which will carry the weight of the lowering assembly. The fixed head assembly shall incorporate no moving parts except for the necessary pulleys, rollers, or sheaves that guide the lowering cables and electrical cable during the lowering operation of the assembly. The fixed head assembly and luminaire lowering ring shall be galvanized steel. All required pulley rollers or sheaves and associated bearings, bushings and shafts shall be constructed of highly corrosion resistant materials not relying upon plating of the parent material for corrosion protection. All pulleys and rollers attached to the head assembly shall have permanently lubricated bearings or bushings.

All parts of the head assembly shall be protected with covers, screens, shields, as necessary, to prevent entrance of dirt, moisture, ice accumulation, nesting of insects or birds or other contaminants harmful to the operation of the lowering device.

All miscellaneous fittings, fasteners, or hardware shall be fabricated from corrosion resistant materials that do not rely on plating for their corrosion protection.

A lightning rod of approved design shall be attached to the top of each pole and shall be firmly attached to the pole shaft or head assembly to provide good electric bonding to the pole shaft.

The entire luminaire lowering ring assembly shall be raised and lowered by three or more symmetrically placed stainless steel aircraft type cables located inside the pole shaft and extending through the head assembly support arms and attached to the lowering ring. Electrical cable supplying energy from the base of the pole to the luminaire ring shall be rough service

mining type cable consisting of 3-600 volt conductors assembled with a messenger into a single cable. No electrical disconnect shall be permitted at the top of the pole. In addition, a stainless steel guide cable or equivalent shall be attached to the inside of the pole shaft to prevent the twisting of the lowering and electrical cables during the raise-lower operation. Each of the stainless steel lowering cables shall be capable of supporting the entire lowering assembly.

When the luminaire ring assembly is in the fully raised position, a mechanism for securing the luminaire ring to the head assembly shall be provided. Such mechanism shall provide support for the lowering ring and shall latch the ring to the head assembly thus permitting the removal of all tension on the cables. All mechanisms shall be designed to provide the operator with a positive means of ascertaining when the raising operation is complete and the ring assembly is in the proper resting position.

The inner portion of the lowering ring shall be equipped with a protective bumper or roller system which will prevent damage to the pole shaft surface and preclude excessive swing during the lowering-raising operation.

Winches shall be operated by an appropriately geared 120 volt electric drive motor with adjustable torque limiter that can be easily hand-transported. One drive motor assembly shall be furnished which will operate all units. The drive motor shall be designed to be readily attached to the pole and/or winch unit and capable of being controlled remotely from at least 6 m [20 ft] from the pole. The drive motor unit shall be equipped with a 480 to 120 volt weatherproof step-down transformer either attached to the drive motor assembly or supplied in a separate enclosure. The transformer shall be of a size compatible with the drive motor and must be adequately grounded to prevent electric shock. A rubber covered heavy-duty type "SO" rated 600 volt cable with connectors shall be provided to test the luminaires when they are in a fully lowered position.

An approved junction box shall be installed in the handhole of each pole that will accommodate the terminations of the underground cable with the cable in the pole serving the luminaires and to include a 480 volt grounded receptacle.

Secondary lightning arresters shall be rated for 650 volts RMS and shall be designed for outdoor use. The arresters shall be installed in each phase conductor to ground and shall be attached in or on the luminaire lowering device in a location accessible for inspection and servicing when the device is lowered.

SECTION 716 - STRUCTURAL ALUMINUM AND RELATED MATERIAL

716.01 Aluminum Railings

a. Aluminum Extrusions Traffic rails, hand rails, splice bars, and pales brackets shall conform to the requirements of ASTM B221M/B221, Alloy 6061-T6 or 6351-T5. Post and post bases shall conform to the requirements of ASTM B221M/B221), Alloy 6061-

T6. Pales shall conform to the requirements of ASTM B429 Alloy 6063-T5. Washers shall conform to the requirements of ASTM B209M/B209), Alloy Alclad 2024-T4.

b. Aluminum Rivets Rivets shall conform to the requirements of ASTM B316M/B316, Alloy 6061-T6 (cold heading). Rivets shall have a button type manufactured head. Self-plugging, aluminum blind fasteners for pale panels shall meet the following requirements: 1) Sleeve-ASTM B211M/B211, Alloy 5056 (Stabilized), 2) Pin - ASTM B211M/B211), Alloy 2017 (Naturally Aged). The driven fastener shall meet the requirements for ultimate shear and tensile strength of Military Specification MIL-R-7885.

c. Miscellaneous Aluminum Parts Rail caps shall be either sand cast or permanent-mold cast and shall conform to the requirements of ASTM B26/B26M or ASTM B108, Alloy A356-T6. All aluminum bars and plates shall conform to the requirements of ASTM B209M/B209), Alloy 6061-T6. Standard structural shapes conform to the requirements of ASTM Specification B308.

d. Steel Anchor Assembly Steel spacers for post anchors shall conform to the requirements of ASTM A36/A36M. Nuts embedded in concrete shall conform to the requirements of ASTM F568 Class 4.6 (ASTM A307).

Anchor bolts, exposed nuts and washers shall conform to the requirements of ASTM F568 Class 8.8 (ASTM A449 or ASTM F1554, Grade 55) and shall be hot dipped galvanized in accordance with ASTM A153 or ASTM B695, Class 50, Type 1.

e. Stainless Steel Parts Cap screws, for fastening clamp bars and set screws for pale-panel brackets shall conform to the requirements of ASTM F593, Alloy Group 1, Condition CW.

SECTION 717 - ROADSIDE IMPROVEMENT MATERIAL

717.01 Fertilizer Fertilizer shall be commercial fertilizer having available elements in conformity with the standards of the Association of Official Agricultural Chemist. The fertilizer shall be furnished in unopened bags with the weight, contents, and guaranteed analysis shown there on or on a securely attached tag.

- (a) Grass Seed Fertilizer shall be;
21% Nitrogen, of which 40% is Urea and 60% is Urea Formaldehyde Slow Release
10% Phosphorus
21% Muriate of Potash, 60% of which is Potassium oxide
- (b) Slow Release Fertilizer tablets - Planting Tablets shall be a long lasting 20-10-5 plus minors 21 gram [$\frac{3}{4}$ oz] tablet.
- (c) Water Soluble Fertilizer shall be;

20% Nitrogen
10% Phosphorus
20% Potassium

Completely water soluble, non-corrosive, without chlorides or carbonates, and containing a color tracer dye.

717.02 Agricultural Ground Limestone Agricultural ground limestone shall have the following mechanical analysis: At least 50 percent shall pass the 150 μm [No. 100] sieve, 90 percent shall pass the 850 μm [No. 20] sieve and 100 percent shall pass the 2 mm [No. 10] sieve. The total carbonates shall not be less than 80 percent.

Agricultural ground limestone may be shipped in containers or in bulk. Packaged material shall be delivered in the manufacturer's standard containers. The containers shall be new and so constructed to assure safe arrival at the site. The net weight of the contents shall not exceed 45 kg [100 lb] per container. The manufacturer's name, a guarantee analysis, and the net weight shall appear on each container. Bulk shipments shall be accompanied by certificates stating manufacturer's name, weight, and guarantee analysis.

Liquid lime may be substituted for agricultural ground limestone when seeding hydraulically. Liquid lime shall be a water soluble solution containing the following analysis:

Calcium Chloride - minimum 13.5%, maximum 14.5%
Ammonical Nitrogen - minimum 3.5%, maximum 4.5%
pH - minimum 10.25, maximum 10.75
Specific Gravity - minimum 1.14kg/l (9.55 lb/gal), maximum 1.15kg/l [9.65 lb/gal]

Liquid lime shall be delivered in the manufacturer's unopened containers. The manufacturer's name, a guaranteed analysis, and the quantity shall appear on each container.

717.03 Seed All seed shall be certified as to mixture, germination, purity, and live seed.

Each variety shall conform to the following:

- A. Percent germination > 80%
- B. Pure Live Seed > 85%
- C. Percent Purity > 85%
- D. Weed seed < 1%
- E. All seed shall be from the current years crop unless recent tests by an approved testing agency demonstrate that older seed meets the above requirements

Seed Mixtures shall consist of seed proportioned percent by weight as follows:

- A. Method #1 - Park Mixture
 - Creeping Red Fescue 45%
 - Kentucky Bluegrass 25%

Chewings Fescue	15%
Perennial Ryegrass	10%
Annual Ryegrass	5%.

B. Method #2 - Roadside Mixture #2

Red Fescue	50%
Sheep Fescue	25%
Red Top	5%
White Clover	10%
Annual Rye	10%

C. Method #3 - Roadside Mixture #3

Crown Vetch	50%
Perennial Lupine	25%
Crimson Clover	15%
Annual Rye	10%

717.04 Mulch

(a) Hay mulch shall consist of long fibered hay, reasonably free from weeds and other undesirable material. No material shall be used which is so wet, decayed or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings, or other short fibered material shall be used unless directed.

Straw mulch shall consist of long fibered straw derived from oats, wheat, rye or other cultivated grains, reasonable free from weeds and other undesirable material. No material shall be used which is so wet, decayed or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings, or other short fibered material shall be used unless directed.

(b) Cellulose fiber mulch shall consist of elongated wood fibers from virgin or recycled sources and post consumer newsprint. The woods fibers shall be tested to show no lead, asbestos or other heavy metals exceeding EPA toxic levels. Cellulose fiber mulch shall be free of refuse, physical contaminants, and material toxic to plant growth. Cellulose fiber shall not contain more than 30% post-consumer newsprint.

(c) Bark mulch shall consist of soft wood bark fragments that have been aged for at least 6 months. Bark mulch shall be free of refuse, physical contaminants, material toxic to plant growth, and reprocessed wood products. Bark mulch shall be a well-graded material conforming to the following:

1. pH between 4.0 - 8.0
2. Particle size 100% passing a 50 mm [2 inch] screen
- 3 Soluble salts content < 4.0 mmhos/cm

(d) Erosion control mix shall be an organic substance of source separated materials, separated at the point of waste generation, that may include; forest residues, bark, paper mill flume grit, stump grindings and aged wood waste. Erosion control mix shall be free of refuse, physical contaminants, material toxic to plant growth, and reprocessed wood products. Erosion control mix may contain rocks less than 100 mm [4 in] in diameter and shall be a well graded material conforming to the following:

1. pH between 5.0 - 8.0
2. Particle size (by weight):
 - a) 100% passing a 150 mm [6 in] screen
 - b) 75 to 85% passing a 19 mm [0.75 in] screen
3. Soluble salts content < 4.0 mmhos/cm
4. Organic Matter 20 to 100%, dry weight basis

(e) Stone mulch shall be clean native stone free of refuse, physical contaminants, material toxic to plant growth, and limestone. Stone mulch shall conform to the following:

1. Particle size:
 - a. 100% < 19 mm [$\frac{3}{4}$ in] screen
 - b. 90% > 6.3 mm [$\frac{1}{4}$ in] screen

717.05 Mulch Binder Shall consist of a commercially developed product for the tacking of hay or straw. Binder shall be free of refuse, physical contaminants, material toxic to plant growth, or asphalt. Paper fiber mulch may be used as a binder at the rate of 3 kg /m² [0.6 lb/ ft²]. Paper fiber mulch shall consist of 100% post consumer newsprint processed to be applied hydraulically.

717.061 Erosion Control Blankets Shall consist of a machine produced rolled blanket of biodegradable organic fibers, evenly distributed over the entire area of blanket, of a consistent thickness, sewn into a biodegradable mesh on the top and bottom surface using a cotton blend thread. The blanket shall remain in place when subject to shear stress of 7.57 kg/m² [1.55 lb/ft²]. The blanket shall remain intact until grass is established. See Section 618.10 - Seeding, Maintenance and Acceptance.

717.063 Ground Anchors Shall consist of metal staples or biodegradable stakes as recommended by the manufacturer of the erosion control blanket to be used.

717.07 Herbicide The herbicide shall be an approved chemical registered in the State of Maine for the required treatment.

717.09 Peat Humus Organic Humus shall be an organic substance meeting the following:

- Minimum organic matter shall be 35% as determined by loss on ignition.
- Particle size shall be 100% less than 25 mm [1 in].
- Soluble salts shall be less than 4.0 mmhos/cm.
- pH shall be between 4.5 and 8.0.

Material shall be Stable (>5) as measured by the Dewar Self Heating Test

Organic humus may be a natural peat from sedge, sphagnum or reed origin, or a compost from source separated materials that may include leaf and yard trimmings, food scrapes, food processing residues, manure and other agricultural residuals, or biosolids. Organic humus shall contain no visible admixture of refuse or other physical contaminants or any material toxic to plant growth.

SECTION 718 - TRAFFIC SIGNALS MATERIAL

718.01 Vehicular Signal Indications

a. Vehicular signal heads for traffic signals and flashing beacons shall conform to or exceed the current edition of the ITE "Standard for Adjustable Face Vehicle Traffic Control Signal Heads". Each housing section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and simple door-locking device. The optical system shall be mounted so that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and constructed so that sections can be removed or added.

There shall be a round opening in the top and bottom of each head to receive 38 mm [1½ in] supporting pipe frame. All parts of the housing, including the doors and end plates shall be of die cast aluminum free from flaws, cracks, blow holes or other imperfections or polycarbonate.

All exposed bolts, screws, hinge pins, and door-locking devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved nonferrous, corrosion-resistant material.

All gaskets, including door, optical assembly, exclusive of lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of a material unaffected by heat.

All light emitting diode optical assemblies shall be wired so that a white wire will be connected to the ground and black or colored wire to the terminal of the LED optical assembly. The wires shall in turn be connected to the terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to terminate all field wires and lamp wires with separate screws. The terminals to which field wires are attached shall be permanently identified or the wiring shall be color coded to facilitate fieldwork. Each LED assembly shall be provided with a removable visor hood unless tunnel hoods or louvered hoods are specified on the plans. Hoods for 200 mm [8 in] sections shall be 175 mm [7 in] long, hoods for 300 mm [12 in] sections shall be 240 mm [9½ in] long.

All heads to be modified shall be retrofitted with light emitting diode optical assemblies for all colors.

When 2 or more vehicular signal heads or a combination of vehicular signal heads and pedestrian signal heads are installed on 1 pole, only 1 conduit riser shall be used. The signal heads shall not be connected together by the use of liquid tight flexible metal conduit and terminal fittings.

All new vehicular signal faces installed at any one intersection shall be of the same make and type.

LED optical assemblies for the 200 mm [8 in] units shall be 650-lumen minimum initial output, 120 volt, 100,000 hour rated life, clear traffic signal lamps. Lamps for the 300 mm [12 in] units shall be 1900-lumen minimum initial output, 120 volt, 100,000 hour rated life.

The intensity and distribution of light from each illuminated signal LED optical assembly shall conform to the latest revisions of the ITE "Standard for Adjustable Face Vehicle Traffic Control Signal Heads", and the "Standard for Traffic Signal LED".

b. Programmed Visibility Vehicular Indications The programmed visibility traffic signal vehicular indication shall optically determine the visibility zone of indication without the use of hoods or louvers. The projected signal may be visible or selectively veiled anywhere within 15° of the optical axis.

The signal head shall be adjustable to various angles between 9° above and below horizontal. No indication shall result from external illumination and each indication shall be illuminated separately. The visibility of the signal indication shall be adjustable within the signal head to fit the lane or lanes in which traffic is to be controlled.

The illumination lamp shall be a nominal 150 watt, 115 volt AC, 3 prong, sealed beamed type, having an integral reflector and an average rated life of 6,000 hours. A dimming device shall be provided to reduce the candela at each signal head for nighttime operation to approximately 15% of the candlepower for daytime operation.

A circular reflector with a specular inner surface shall mate the lamp to a diffusing element.

An internal imaging surface shall be provided to permit an effective veiling system to be applied as determined by the desired visibility zone. The Contractor shall notify the Resident 48 hours prior to the application of the veiling system. The optical limited-diffuser shall be provided with positive indexing means and shall be composed of heat resistant glass.

The objective lens shall be a high resolution planar incremental lens thermally sealed within a flat laminate of weather resistant acrylic. The lens outline shall be symmetrical. Lens colors shall conform to the latest ITE transmittance and chromaticity standards.

The signal shall be housed in cast aluminum, conforming to the latest ITE alloy and tensile requirements. Each section shall have a sun visor. The cast aluminum shall have a

chromate preparatory treatment before the application of green or yellow baked enamel prime and finish. The lens cover and the interior of the case shall be flat black. Hinge and latch pins shall be stainless steel. All access openings shall be sealed with weather resistant rubber gaskets.

The lamp fixture housing shall be readily accessible and lamp replacement shall not require special tools nor necessitate major disassembly.

Electrical connections between the case and lamp holder shall be an interlock assembly that disconnects the lamp holder when open. Number 16 wire shall be used to connect the lamp receptacle to the signal head terminal.

The signal head shall be capable of being mounted to standard 38 mm [1½ in] fittings as a signal head section, as a multiple section face or in combination with other signal heads.

The signal section shall be provided with a rigid connection that permits tilting from at least 9° above or below the horizontal while maintaining a common vertical line through couplers and conduit. No special tools should be needed for servicing or mounting.

718.02 Pedestrian Signal Indications The pedestrian traffic control signal heads shall conform to the ITE, "Standard for Adjustable Face Pedestrian Signal Heads", latest Edition. The housing shall be dust and moisture proof and corrosion resistant and shall provide easy access to all components. All pedestrian signal heads shall have a sun visor.

All pedestrian traffic control signal heads of the incandescent type shall be as outlined in the above Standard. All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

The "Don't Walk" and "Walk" indications shall be separate heads and the "Don't Walk" indication shall appear directly over the "Walk" indication. The "Walk" message shall be lunar white and the "Don't Walk" message shall be Portland orange.

Head sizes shall be standard nominal 250 mm [9 in] in minimum dimension unless otherwise specified.

LED optical assemblies for 225 mm [9 in] units shall be 650-lumen minimum initial output, 120-volt, 100,000 hour rated life.

LED optical assemblies for 300 mm [12 in] units shall be 1,900-lumen minimum initial output, 120-volt, 100,000 hour rated life.

When 2 or more pedestrian signal heads are installed on 1 wood pole, only 1 conduit riser shall be used. The pedestrian signal heads shall not be connected by the use of liquid tight flexible metal conduit.

Pedestrian signal heads, which use fiber optic bundles to form the message, shall achieve the color of the messages by filters between the light source and the optical bundles. The legends shall be 125 mm [5 in] minimum in height with a 16 mm [$\frac{5}{8}$ in] stroke. The housing materials shall conform to the requirements for conventional pedestrian signal housings. The message shall be illuminated by a light source designed to operate on a 120-volt source and shall be rated for 100,000 hour average life. The flashing message shall be accomplished by use of a solid-state flasher required for conventional pedestrian signal indications.

718.03 Signal Mounting All trunnions, brackets, and suspensions used for assembling and mounting signal control faces shall be entirely weather tight. The inside area of the cross section of the tubular arms shall not be less than the inside area of 38 mm [1½ in] IPS pipe to permit the signal control wires or cable to be inserted through them.

After final adjustment, all vehicular and pedestrian signal heads, regardless of mounting arrangement, shall be fastened by a positive locking device acceptable to the Resident. This device shall prevent any deviation from the position set, but shall allow for readjustment of the signal head later in the same installation or in another installation without the necessity of damaging any part of the signal head.

718.04 Vehicular Loop Detectors Vehicle detectors shall consist of wire loops and self-contained detection equipment capable of registering independently the presence or passage of any vehicle passing over the loop at any speed up to 110 km/hr [70 mph] and at any temperature between -37°C and +74°C [-35°F and 165°F]. Each loop detector shall contain its own integral power supply and shall operate between 95 VAC and 135 VAC. The input power shall be protected by fuse or resettable circuit breaker.

The detector amplifiers shall be self-tuning, solid state construction except for the output relay. Printed circuit design shall allow the components to be removed and replaced without permanent damage to the printed circuit boards or tracks.

Detector amplifiers installed in a common cabinet shall have a frequency difference and shall not interfere with the operation of other detector amplifiers installed in the same cabinet.

All input and output circuits for each amplifier shall enter by a single connector provided with a threaded shell. All controls, indicator lights, meters, fuseholders, circuit breakers and connectors shall be mounted on the front panel of the detector amplifier. All controls shall be adjustable without the use of tools and the controls shall be clearly and permanently identified.

The detector unit shall show a visible indication of vehicle calls. After a power interruption, the units shall return to normal operation within 30 seconds. If any vehicle stops over a portion of the loop registering a call, the detector shall be capable of detecting additional vehicles traversing the loop after approximately 15 seconds.

Detectors shall detect vehicles by lanes of traffic and shall not detect traffic moving away from the intersection when properly positioned in normal travel lanes. Detection must be

positive and not erratic under all actual operating conditions with the exception of storm damage to the detector.

All detectors shall be capable of detecting all four-wheeled vehicles for all lengths of lead-in up to 230 m [750 ft] for single detection loops and for a combined lead-in length of 230 m [750 ft] in the case of multiple loops.

Detector loop wire shall be number 14 THWN stranded wire, moisture and heat resistant. Lead-in cable shall conform to the detector manufacturer's recommendations. The wire shall be encapsulated in vinyl tubing over its entire length.

No damage shall occur in the detector if the pavement loop or lead-in becomes short-circuited.

718.05 Microwave Detectors Microwave detectors shall work on an operational frequency of 10.525 GHZ. The detection method shall be microwave with adjustable patterns with a response time of 165 milliseconds and an adjustable hold time of 0.5 to 5 seconds. It shall be powered from 10 VAC to 24 VAC. All contacts shall be form C, 5 amp rated. The detector shall have a fail-safe microprocessor circuit so that if the unit fails it will place the controller in recall on the apparent phase.

718.06 Pedestrian Detectors Pedestrian push button detectors shall be weatherproof and constructed to eliminate the possibility of electrical shock in all weather conditions.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw type terminals, rated 15 amperes at 125 volts, AC and shall have the following characteristics:

- a. The switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.
- b. Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. When required, saddles shall be provided to make a neat fit.

718.07 Controllers All controllers shall be solid state menu driven keyboard units meeting NEMA standards and capable of operating in fixed time, semi-actuated and actuated modes or as designated on the plans. Controller shall have a programably "EE prom" chip with an internal real-time clock/calendar capable of daily, weekly, and yearly events time programming. The controller shall be designed to provide the number of intervals shown on the plans without any auxiliary equipment. Solid state controllers shall be provided with conflict monitors as specified in Section 718.11.

All equipment inputs, outputs, and terminals shall be identified by the phase designations shown on the plans.

The reliability of the equipment shall be demonstrated by test performance that will confirm that the controller unit, fully wired cabinet, and auxiliary equipment meet the operational and functional requirements of the plans and specifications.

The Contractor shall be responsible for providing all information describing the operation of the equipment necessary to facilitate the completion of the tests. All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams and all operation manuals shall be submitted to the Resident at the time the controllers are delivered for testing. These diagrams shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such a manner as to be readily interpreted.

The controller shall be delivered with all documentation manuals as per Section 643.17 to the Maine Facility, US Route 2, Palmyra, Maine, mailing address RFD Box 421, Pittsfield, Maine, 04967, with all internal connections made and ready for testing. The test will be performed under simulated field loads or manufacturer's design loads, whichever are greater. Testing will be performed by the Department.

The Contractor shall allow 21 days for the testing of each controller, commencing on the day the controller is delivered to the test site, exclusive of the number of days necessary for the Contractor to respond to defect notices and the number of days the Contractor requires to correct the defective equipment.

The test shall consist of not less than five days of continuous, satisfactory operation. If unsatisfactory performance of the controller develops during the test, the Contractor shall remove the defective equipment for repair within five working days after notification, correct the deficiency and the controller shall be retested, until the 5 days of continuous satisfactory operation are obtained. If repeated failures occur, the entire controller may be rejected, requiring the Contractor to submit a new controller for testing. Delays to the contract resulting from unsatisfactory test performance due to continued equipment failure will not be considered as a valid reason to justify extension of the contract time.

The Contractor will be notified when testing of the traffic signal equipment has been completed. It shall be their responsibility to transport the equipment to the work site.

Each traffic controller unit, flasher and all other current interrupting devices shall be equipped with a suitable radio interference suppressor installed at the input power point. Interference suppressors shall be designed to minimize interference in both broadcast and aircraft frequencies. Suppressors shall be designed for 125% of the total connected load and shall meet standards of the UL and the EIA.

The type of controller, auxiliary equipment and other operational features shall be as noted on the plans.

All equipment, except pedestrian push buttons, shall be designed to operate on 120 volt, 60 hertz. Operation shall be satisfactory at voltages from 105 to 130. The voltage for pedestrian push buttons shall not exceed 18 volts.

a. Auxiliary Functions All controllers shall be capable of providing flashing operation of the signal lights, as indicated on the plans. Transfer from flashing operation or to flashing operation shall conform to the MUTCD. The clock for auxiliary functions shall be a solid state time clock or module.

If noted on the plans, preempt circuits shall be provided for emergency vehicles and/or railroad crossings. The clearance and preempt indications shall be as noted on the plans. Preempt circuits shall function during stop and go and flashing operation unless otherwise noted. The duration of clearance and preempt intervals shall be adjustable over the range noted on the plans and shall be labeled according to function. The railroad preempt circuit shall be designed to operate as a fail-safe loop through a normally made contact on the railroad's control relay in the railroad's control cabinet. Railroad preemption shall have precedence over all preemption intervals for other purposes.

Actuated vehicle phases and actuated pedestrian phases shall be served in that interval of the cycle indicated on the plans. Time for an actuated interval shall be taken from the non-actuated phase(s) as noted on the plans.

Automatic transfer to or from flashing operation shall conform to the MUTCD. Manual advance of the intervals by use of hand cord control shall cause the controller to advance to the next programmed interval only upon pulse signal from the hand cord circuit, interval timing shall hold the interval for the minimum programmed amber and red clearance intervals.

b. Solid State Controllers The controller unit shall be enclosed in a sheet metal case with protective painted finish, designed to permit easy access to the interior and removal of printed circuit boards and modules without the use of special tools. All program controls, fuses, and indicator lights shall be mounted on the front panel and shall be clearly and permanently labeled. Modules of unlike function shall be mechanically keyed or electrically interlocked to prevent placement in the wrong location. Each module shall be identified with the symbol shown on the plans with an embossed, color contrasting, plastic label. All components shall be marked for identification compatible with the maintenance manual for the controller unit, including components mounted on printed circuit boards.

When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit, except yellow and red clearance intervals shall be timed for the duration programmed.

An exclusive pedestrian phase shall not extend or recycle until a vehicle phase has been serviced. When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit except yellow and red clearance intervals shall be timed for the duration programmed. Automatic transfer from or to flashing operation shall conform to the MUTCD.

Pedestrian phases shall not be extended by actuations, during the walk or clearance interval. Actuations during the clearance intervals shall be placed in memory.

718.08 Controller Cabinet The traffic signal control equipment shall be enclosed within a dust and moisture-proof aluminum or stainless steel housing with an auxiliary door in door feature. The door hinge pins shall be made of stainless steel. The cabinet shall be installed with the back toward the nearest line of traffic unless otherwise directed by the Resident.

The controller cabinet shall be of sufficient size to accommodate all control equipment including temperature control equipment. It shall be designed to be attached to the type of pole indicated in the contract plans. If attached to a traffic signal post, it shall be integral with the post giving the appearance of the signal post passing directly through the cabinet. If the controller cabinet is to be ground mounted, details of the installation will be shown on the plans. Piano type hinges on controller cabinet doors shall be fabricated of stainless steel with a stainless steel hinge pin.

All manual control switches, push button control, flashing switch, signal switch and any other specified switches shall be located to be accessible within the outside door, without exposing the controller mechanism.

The flashing mechanism for flashing beacon installations must be enclosed within a dust and moisture proof aluminum cabinet with a hinged door.

The flasher cabinet shall be of sufficient size to accommodate a 2 circuit solid state flashing mechanism and other necessary equipment. It shall be designed to attach to the type of pole indicated in the contract plans. The flasher cabinet shall be vented to prevent excessive heat build-up.

The locks for the door of the flasher cabinet shall be the type shown on the plans. Two keys shall be furnished with each control lock.

All cabinets housing solid-state traffic signal control equipment shall be provided with a thermostatically controlled ventilating fan and throwaway glass fiber air filters. The electric fan shall have ball or roller bearings and shall have a capacity of 2.8 m³ [100 ft³] per minute. The ventilating system shall be designed to prevent the entrance of rain, snow, dust, and insects. The fan and vents shall be arranged in such a manner that the air intake is at the cabinet bottom and the exhaust is at the cabinet top. The filter shall be firmly held in place such that cracks and openings are eliminated to ensure that all air is filtered. The fan shall be thermostatically controlled with an adjustable upper limit of 38°C to 60°C [100°F to 140°F] and a differential of not more than 5°C [10°F].

The locks for the switch compartment door of the controller cabinet shall be the type shown on the plans. The main door shall be a lock of the tumbler type. Two keys shall be furnished with each control lock.

All traffic signal controller cabinets shall be supplied with a convenience outlet, a standard 3-wire grounding duplex receptacle, 20 amp capacity and a lamp socket and 1900 lumen lamp.

A police panel shall be provided behind the auxiliary door and shall contain a switch to select "flash-automatic" function, "automatic-manual" function, "signals on-off" function and a manual control cord. Switch terminals on the rear of the main cabinet door shall be insulated so that no live posts are exposed. The "signal on-off" switch shall allow the signal indications to be de-energized, but power to all other control circuits shall not be disrupted. Switches shall be labeled and rated for load current. Traffic signal controller cabinet main doors over 0.55 m² [6 ft²] in area shall be provided with a stop to limit door opening to both 90° and 180° +/- 10°. The stop shall be provided with a catch that can be operated when the door reaches these 2 positions and will hold the door open securely until released. Controller cabinets designated on the plans to be ground mounted shall have a pliable seal composed of caulking compound or mastic placed between the cabinet base and the concrete foundation to prevent dust and dirt from entering the cabinet. The bottom of the controller cabinet shall be mounted on an aluminum non-breakaway transformer base as shown on the plans.

The cabinet shall be supplied with sufficient shelf space for all control units. Receptacles for relays, shelf spaces below all removable control equipment, contactors, switches, fuses, circuit breakers and terminal blocks shall be identified with plastic labels embossed with the symbol used on the plans to indicate the related function.

718.09 Flasher The flasher shall be a two circuit solidstate device with no contact points or moving parts, producing between 50 and 60 flashes per minute with a 50% to 67% duty cycle. The flasher mechanism shall be mounted on a plug-in base with a plug-in mounting. The flasher relay shall energize the flasher and transfer signal light circuits from the controller unit to the flasher. The flasher shall be capable of breaking and carrying 10 amps on each circuit at 125 volts. All amber indications shall be on one circuit and all red indications shall be on the other circuit. The flasher shall be protected from lightning damage by a device intended for use with solid state equipment. The flashing mechanism shall be independent of the controller unit and shall remain in operation upon shutdown of the controller or removal of the controller unit from the cabinet. The pedestrian indications shall be flashed with a separate solid-state flasher.

718.10 Program Selection The weekly program selection unit shall be capable of automatically supervising the operation of cycle 1, cycle 2, cycle 3, split 1, split 2, split 3, reset 1, reset 2, reset 3, and flashing operation. The weekly program selection unit shall allow selection and/or omission of these functions to be varied on a daily basis. The weekly program selection unit shall enable function transfers to be made as often as 15 minutes.

Solid state devices used to automatically select dial, reset and flashing modes shall meet the applicable functional requirements of mechanical devices. They shall maintain the preset program during power interruption and shall continue timing functions using a reserve power source.

718.11 Contacts and Relays All contacts used in connection with interval indications shall be of pure coin silver or its equivalent and shall be capable of breaking and carrying at least 15 amperes at 120 volts AC. The Contractor is directed to arrange the internal wiring and number of circuits so that the contact rating is not exceeded.

All actuated controllers shall be equipped with external type signal light relays.

Relays shall not be used in connection with any automatic non-flashing red, yellow or green indication in installations having pre-timed electro-mechanical equipment, without the approval of the Resident.

Relays shall be designed for continuous duty. Relays shall be designed to operate at ambient temperatures from -35°C to +70°C [-30°F to +158°F].

Each relay shall be mounted on a plug-in base with a plug-in mounting. Coils shall have a power consumption of 10 volt-amperes maximum and shall be designed for continuous duty on 120 volts, AC.

A leakage resistor, which shall permit current to pass through the relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed with each external signal light relay to overcome residual magnetism effects.

All relays shall be of a rating sufficient to carry the electrical loads imposed upon them. A sufficient number shall be provided so that the total load is distributed among the various circuits in such a manner that the rating of each relay is 150% of the load.

The monitor unit shall be connected to the field terminals of the signal light circuit to provide protection against conflicting green, yellow or walk indications being simultaneously energized as a result of controller failure, relay or solid state switch failure, short circuited field wiring or other failures.

When a conflict is detected, the monitor unit shall cause the signal system to commence flashing operation; energize the stop-timing circuit of the controller while controller power shall remain on; lock-in flashing operation until manual actuation of the momentary contact reset push button; remove power from the signal light circuit; disable all functions of the "Flash-Automatic" and "Automatic Manual" switches in the police panel.

Each circuit of the solid state switching devices shall have a minimum rating of 1,000 watts for tungsten lamp load at 120 volts, AC. The solid state switching devices shall be plug- in mounted to a base. Solid state switching devices shall be protected from transient voltages and lightning by components especially designed for use with solid state devices.

Circuit breakers shall be approved and listed by the UL. The operating mechanism shall be enclosed and shall be trip-free from operating handle under load and shall be trip-indicating. All circuit breakers shall be quick-make, quick-break on either automatic or manual operation. Contacts shall be silver alloy enclosed in an arc quenching chamber. Overload tripping of breakers shall not be influenced by an ambient temperature range of from -18°C to +70°C [0 to +158°F].

718.12 Conductors The number and size of conductors required in each cable is indicated on the plans. All conductors shall be stranded copper conductors. Multiconductor cables shall

conform to the latest revisions of IMSA Specification Number 19-1 or 20-1. The service ground rod shall be 2400 mm by 16 mm [8 ft by 5/8 in] copperclad rod.

The service wiring shall be single conductor number 6 AWG THW stranded copper black insulated and number 6 AWG THW stranded copper white insulated rated 600 volts.

All circuits for the timer and each auxiliary control unit shall terminate in a multiple contact connector. Conductors shall be attached to all pins of the connector and cabled. Conductors of the cable, except spares, shall be fitted with terminal ends compatible with the terminal block and shall have identifying bands. The ends of all spare conductors shall be taped.

SECTION 719 - SIGNING MATERIAL

719.01 Reflective Sheeting The reflective sheeting shall consist of a retro-reflective lens system having a smooth outer surface. The sheeting shall have a precoated adhesive on the back side, protected by an easily removable liner.

The reflective sheeting and its components shall conform to all the requirements of FHWA "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects", FP-92, Section 718.01. Engineering grade reflective sheeting shall meet the reflective intensity requirements for Type II sheeting as shown in Table 718-1, Section 718.01 - Vehicular Signal Indications, FP-92. High intensity reflective sheeting shall meet the reflective requirements for Type III sheeting as shown in Table 718-3, Section 718.01 - Vehicular Signal Indications, FP-92.

Reflective sheeting, used in sign construction, shall have been manufactured within the six months immediately prior to fabrication of each sign. Upon delivery at the job site of each shipment of signs, a letter of certification shall be provided by the Contractor that the reflective sheeting conforms to the requirements contained herein.

For Type I Guide Signs, all reflective sheeting shall be color matched on each sign unit.

719.02 Demountable High Intensity Reflectorized Letters, Numerals, Symbols and Borders Demountable reflectorized letters, numerals, symbols and borders shall consist of cut out high intensity sheeting, conforming to FHWA, "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects", 1992, FP-92, Section 718.01(d).

719.03 Aluminum Extrusions The extruded aluminum planks shall be bolted type with dimensions, holes, lengths, and cross sections as detailed on the plans. The extruded aluminum molding for edging of the extruded aluminum sign panels shall be of the cross section as detailed on the plans. Extruded aluminum planks shall conform to ASTM B221M/B221, 6063-T6, 6005-T5, or 6061-T6. The extruded aluminum planks and molding shall be free from all corrosion and dirt and the face and edges shall be true, smooth, and free from burrs and breaks.

a. Degreasing Required on aluminum plank by either of the following methods:

1. Vapor Degreasing shall be by total immersion of the plank in a saturated vapor of trichloroethylene or perchloroethylene. Trademark printing shall be removed with lacquer thinner or controlled alkaline cleaning system.

2. Alkaline Degreasing - Planks shall be immersed in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specification. Immersion time shall depend upon the amount of soil present and the gauge of the metal.

b. Etching

1. Alkaline Etch The pre-cleaned aluminum surface shall be well etched in an alkaline etching material that is controlled by titration, use time, temperature and concentration specified by the solution manufacturer and rinsed thoroughly. Smut shall be removed with an acidic, chromium compound type solution as specified by the solution manufacturer and then thoroughly rinsed.

2. Alodine 500 or 1,200 is acceptable.

c. Drying Material may be air-dried or oven dried. Metal shall not be handled between all cleaning and etching operations and the application of Reflective Sheeting, except by devise or clean gloves. There shall be no opportunity for metal to be exposed to grease, oils, or other contaminants before application of Reflective Sheeting.

d. Fabrication All fabrication shall be completed before metal degreasing.

719.04 Aluminum Sheets All blanks shall be made of 5052-H38 or 6061-T6 aluminum. The Contractor shall guarantee the material to be free of buckles, warp, dents, cockles, burrs and defects resulting from fabrication.

a. Degreasing Required on sheet aluminum by either of the following methods:

1. Vapor Degreasing Sign blanks shall be totally immersed in a saturated vapor of trichloroethylene or perchloroethylene. Trademark printing shall be removed with lacquer thinner or controlled alkaline cleaning system.

2. Alkaline Degreasing Sign blanks shall be totally immersed in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specifications. Immersion time shall depend upon the amount of soil present and the gauge of the metal.

b. Etching

1. Alkaline Etch The pre-cleaned aluminum surface shall be well etched in an alkaline etching material that is controlled by titration, use time, temperature and concentration specified by the solution manufacturer, and rinsed thoroughly. Smut shall be removed with an acidic, chromium compound type solution as specified by the solution manufacturer and then thoroughly rinsed.

2. Alodine 500 or 1,200 is acceptable.

c. Drying Material may be air-dried or oven dried. Metal shall not be handled between all cleaning and etching operation and packaging, except by device or clean gloves. There shall be no opportunity for metal to come in contact with grease, oils, or other contaminants prior to application of to packaging and shipping.

d. Fabrication All fabrication, including shearing, cutting, and punching of holes, shall be completed before metal degreasing. Fabrication of all metal parts shall be accomplished in a uniform and skillful manner. The surface of all sign panels shall be flat.

The minimum sheet thickness shall be 2.00 mm [0.08 in] for signs of an area of 1.1 m² [12 ft²] or less and shall be 3.18 mm [0.125 in] for signs over 1.0 m² [12 ft²] unless otherwise specified.

e. Chromate Treatment Treatment shall be in accordance with ASTM B449 Class I.

719.05 Plywood The plywood shall conform to the following requirements:

a. Face stock Face veneers shall be Grade A.

b. Core and Cross Veneers Core and crossband veneers shall be Grade B or better and shall be solid jointed.

c. Glue The entire area of each contacting veneer surface shall be bonded with a waterproof adhesive that meets the test requirements for exterior type.

d. Overlay The overlay shall be of the high-density type. It shall be a minimum of 0.29 kg/m² [60 lb/1,000 ft²] surface, shall be at least 0.229 mm [0.009 in] thick, and have a minimum resin content of 40% based on the dry weight of the impregnated fiber. It shall consist of at least 2 sheets of resin-impregnated fiber of sufficient resin content to bond itself to the plywood. Manufacturing precautions shall be taken to prevent overlay surfaces from coming into contact with any substance that would inhibit adhesion of paint or reflective sheeting. The overlay shall be natural color.

e. Thickness The thickness of plywood shall be 16 mm [⁵/₈ in].

f. Testing The plastic overlay shall not delaminate from the plywood after being subjected to the exterior boiling test for glue line durability.

719.06 Demountable Reflectorized Delineators Delineators shall be diamond reflectors approximately 75 mm [3 in] square or shall be rectangular, adhesive coated reflective sheeting permanently adhered to a sheet aluminum backing. All delineators on a project shall be the same type. Single delineators shall be clear or silver-white; double and triple delineators shall be amber.

a. Single delineators shall have one 6 mm [$\frac{1}{4}$ in] square hole for center mounting. Double and triple delineators shall have two 6 mm [$\frac{1}{4}$ in] square mounting holes on the vertical centerline.

Single delineators shall be 75 mm by 75 mm [3 in by 3 in] diamonds with 19 mm [$\frac{3}{4}$ in] radius corners and two 6 mm [$\frac{1}{4}$ in] square mounting holes, 75 mm [3 in] on center.

Double delineators shall be 75 mm by 150 mm [3 in by 6 in] rectangles with 19 mm [$\frac{3}{4}$ in] radius corners and two 6 mm [$\frac{1}{4}$ in] square mounting holes 125 mm [5 in] on center.

The aluminum shall be 6061-T6, ASTM B209 or 6063-T6 or 6005-T5 1.60 mm [0.063 in] thick sheet properly degreased and etched or treated with a light, tight amorphous chromate type coating.

The reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

b. General Requirements and Packaging. The finished delineators shall show careful workmanship, be free of burrs, scratches or damaged reflective surface.

Delineators shall be packaged in such a manner as to insure their arrival at destination in undamaged condition. Delineators shall not become wet in storage or shipment.

719.07 Assembly and Mounting Hardware - General The attachment of signs shall be in accordance with the contract documents and the appropriate hardware prescribed in this Section. Requests for substitution for all specified material shall be submitted in writing with full documentation, including but not limited to specifications and mill certification reports, enabling the Department to evaluate the proposal promptly.

719.071 Aluminum Planking The bolt assembly required to fasten the extruded aluminum planks together shall conform to the designs used in standard commercial processes for the selected type of extruded aluminum panels. Guidance for bolt hole punching and typical plank-to-plank attachment is provided in the contract documents.

719.072 Overhead Signing Sign panels mounted to independent sign support structures and support structure components mounted to bridges passing over the highway are considered to be overhead signing. Overhead signing shall be mounted on W150 by 14 [W6 by 9] steel beams conforming to the requirements of ASTM A992/A992M, galvanized in accordance with AASHTO M111 (ASTM A123), or the same size aluminum beams conforming to ASTM B221M, alloys and tempers of 6061-T6, 6063-T6 or 6005-T5. These components shall be horizontally spaced a maximum of 1.6 m [$5\frac{1}{4}$ ft] on center, extending from the bottom of sign panel to the top. If supplemental signs are included in the contract, these beams will extend from the bottom of the main sign panel to the top of the supplemental sign panel. The maximum distance from the edge of the sign to the center of the W150 by 14 [W6 by 9] shall not exceed approximately 1 meter [$3\frac{1}{4}$ ft].

On independent sign support structures, these W150 by 14 [W6 by 9] beam components shall be fastened to chords with a pair of appropriately sized U-bolts on each side of the web at each fastening location. A similar pair of U-bolt assemblies shall be used in attaching each chord of an overhead component to upright supports. U-bolts for steel support structures shall conform to ASTM A449, Type 1 or 2. The U-bolt hardware, which includes nuts, flat washers and helical lock washers, shall be galvanized in accordance to AASHTO 232 (ASTM A153 or B695, Class 50, Type 1). Washers shall conform to the requirements of ASTM F436. The U-bolt material for aluminum support structures, or a combination of steel and aluminum structural components, shall be stainless steel conforming to the requirements of ASTM F593, alloy group 1, with a minimum yield strength of 310 Mpa [45 ksi]. Steel support structures may also utilize stainless steel hardware assemblies as an alternative to galvanized steel. Nuts shall be of the locking type with nylon inserts. Washers shall conform to the requirements of ASTM A276, Type 302. Flat washers, without helical lock washers, will be acceptable in this stainless steel assembly.

On bridge mounted structures, the fastener configurations shall be depicted in the contract documents.

719.073 Post Clip Hardware For Overhead Signing Signs mounted steel or aluminum W shape beam components shall be attached using post clip hardware as described in this Section as well as the contract documents. Overhead signing shall have post clip assemblies fastened in pairs, one on each side of the web of the W shape beam, at all locations on the backside of the extruded plank panels that provide a groove accommodating a post clip bolt and assembly. Post clips shall be 356-T6 aluminum conforming to the requirements of ASTM B108. The post clip bolt material for overhead signing shall be stainless steel conforming to the requirements of ASTM A193/A193M, AISI Type 304, Grade B8. The post clip bolt nut shall be stainless steel material conforming to the requirements of ASTM A194/194M, AISI, Type 303, Grade 8F and of the locknut type with nylon inserts. Flat washers of these assemblies shall be stainless steel material conforming to the requirements of ASTM A276, Type 302.

719.074 Post Clip Hardware For Roadside Signing Signs mounted on other than overhead locations may be mounted using aluminum hardware. The aluminum post clips shall be 356-T6 aluminum conforming to the requirements of ASTM B108. The post clip bolts, washers and nuts shall conform to the requirements of aluminum alloy 2024-T-4 (bolts and washers) and alloy 6061-T6 or 6262-T9 (lock nuts).

719.073 Roadside Signing Aluminum signs mounted on U-channel posts shall be fastened with M8 by 38 mm [$\frac{5}{16}$ in by 1½ in] stainless steel bolts, washers, and self-locking type nuts. The bolts shall conform to the requirements of ASTM F593. A washer, either a white nylon or neoprene or stainless steel ASTM F593 shall be used between the head of the bolt and the face of the sign.

Plywood signs mounted on U-channel posts shall be fastened with M8 by 60 mm [$\frac{5}{16}$ in by 2½ in] stainless steel cap screws and hex nuts conforming to ASTM F593, and a washer either white nylon or neoprene or stainless steel ASTM F593 shall be used between the head of the bolt and the face of the sign.

Delineator assembly hardware shall consist of M6 by 60 mm [$\frac{1}{4}$ in by $2\frac{1}{4}$ in] stainless steel bolts, washers, and self-locking type nuts. The bolt assembly shall conform to the requirements of ASTM F593.

SECTION 720 - STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS

720.01 Aluminum Supports Extrusions for aluminum supports shall conform to ASTM B221M (ASTM B221) or ASTM B429, Alloy 6061-T6 or 6063-T6. Castings for use with aluminum supports shall conform to ASTM B26/B26M or B108, Alloy 356.0-T6, except that castings for parts having a non-structural application, such as pole caps or bolt covers, may be temper F. The T6 tempers specified for Alloys 6063 and 356.0 shall be obtained by the proper heat treatment of the assemblies after all welding for the base and if required, for the handhole reinforcement has been completed. No welding will be allowed on the shaft other than as required for the attachment of the shoe base, handhole reinforcement and bracket arm. All welding for aluminum light standards shall conform to the current edition of AWS Structural Welding Code - Aluminum D1.2.

The exterior of all parts shall have a satin brushed or satin etched finish. The assemblies shall be free of bulges, dents, and cracks and on external surfaces, discoloration and scratches. The presence of any of these defects or any other imperfection detrimental to strength or appearance may be cause for rejection by the Resident. All assemblies shall be tire wrapped for protection during shipment, storage, and handling.

All ends of shafts open to the weather shall be fitted with a cast-aluminum or formed aluminum cap secured in place with set screws.

All assemblies shall be permanently marked on the edge of the base plate or flange, indicating alloy and temper of base plate/flange and shaft, as well as the diameter and wall thickness of the shaft.

a. Light Standards, Mast Arm Poles, Strain Poles and Dual Purpose Poles Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices, except that shafts with a length of over 12 m [40 ft] may be fabricated with one splice at approximately mid-height and dual purpose poles may be fabricated with a splice immediately above the mast arm attachment. The minimum wall thickness of the shaft shall be 4.78 mm [0.188 in]. A hand hole of approximately 0.016 m² [25 in²] in area, reinforced to maintain the full design strength of the shaft, shall be provided with the handhole center approximately 450 mm [18 in] above the base. Provisions for internal grounding shall be incorporated in the handhole reinforcement. A hole, fitted with a rubber grommet, shall be provided in the shaft to match the wire-way of the bracket arm or mast arm, except that strain poles shall be provided with a wire inlet as shown on the standard details. Bases shall be shoe type and shall be supplied with suitable covers for the anchor bolts. Anchor bolt covers shall be securely fastened to the base by means of one or more stainless steel Phillips or hex head screws with a minimum size of 6 mm [$\frac{1}{4}$ in]. Bases shall be welded to the shaft

with both an internal and external continuous fillet weld. The use of sleeve type bases or other bases not requiring welding of the shaft to the base and the use of reinforcing sleeves will not be allowed.

Dual-purpose poles shall be provided with a pull wire for the luminaire.

b. Colonial Light Standards Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices. The minimum wall thickness shall be 3.175 mm [0.125 in] and the minimum diameter at the base shall be 125 mm [5 in]. The length of the shaft plus the base shall be 4.34 m [14¼ ft], with a 100 mm [4 in] long by 75 mm [3 in] OD straight section at the top to accept the pole top luminaire. The entire assembly of pole and base shall be black anodized. Bases shall be handhole type with a handhole of approximately 0.016 m² [25 in²] in area and equipped with an approved locking device on the handhole cover. The bases shall have internal flanges capable of accepting four M20 [¾ in] anchor bolts, equally spaced on a 250 mm [10 in] diameter bolt circle. The bases shall be welded to the shaft with both an internal and an external continuous fillet weld.

c. Pedestal Poles Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices. The minimum outside diameter at the base shall be 150 mm [6 in] and the minimum wall thickness shall be 3.175 mm [1/8 in]. The length of the pole plus the base shall be 3 m [10 ft], except that the length of poles supporting only pedestrian heads shall be 2.4 m [8 ft]. Bases shall be transformer type with suitable covers for the anchor bolts. The bases shall be welded to the shaft with an external and an internal fillet weld.

d. Bridge, Cantilever and Butterfly Type Sign Support Structures The configuration of the foundations, bases, shafts, and trusses shall be of the Contractor's design, as approved by the Engineer, and shall use only material as specified above. Sleeve type bases or other bases not requiring welding to the shaft and the use of reinforcing sleeves will not be allowed.

720.02 Aluminum Mast Arm and Bracket Arm Mast arms and bracket arms shall be of the same materials as the matching pole and have a similar finish. Member cross sections shall be either round or elliptical and have a minimum wall thickness of 3.175 mm [1/8 in]. Internal diameters, bends, joints, and attachments shall permit internal wiring in the upper member of the arms. Fixtures for attaching the arms to the poles shall be either castings or extrusions, sized to meet the design requirements, and shall be designed to prevent rotation of the arms about the poles. Any mechanical means used to prevent rotation shall completely penetrate both the fixture and the shaft and the use of set screws will not be allowed. All welding for aluminum light standards shall conform to the current edition of AWS Structural Welding Code - Aluminum D1.2.

a. Mast Arms for Signals Mast arms shall be of the tapered tube truss type design, consisting of an upper and a lower member with vertical struts, welded to form an integral unit or single member tapered arm. Mast arms shall be equipped with sturdy signal hangers

and/or appropriate tenons for mounting the signal heads and shall have weatherproof wire inlets located close to the suspended signal heads.

b. Bracket Arms for Luminaires Bracket arms shall be of the single member or truss type. Single member type bracket arms shall be of the tapered upsweep design. Truss type bracket arms shall be of a tapered tube design, consisting of an upper and a lower member and a single vertical strut, welded to form an integral unit. Arms shall be equipped with an appropriate tenon for the attachment of the luminaire.

720.03 Steel Supports Tapered shafts for steel supports shall conform to ASTM A595, Grade A or approved equal. Straight shafts for steel supports shall conform to ASTM A53, Grade B, ASTM A500, Grade A and B, or an approved equal. Base plates and flanges shall be fabricated of steel plate conforming to ASTM A709M/A709, Grade 250 or 345 [Grade 36 or 50] and sized to transmit the full design load of the shaft. Steel shapes shall conform to the requirements of ASTM A992/A992M. Flange chord splice plates and base plates are considered main load carrying members and shall comply with the requirements of Section 713.01 - Structural Steel. All work shall conform to the applicable provisions of Section 504 - Structural Steel.

The interior and exterior of all support structure components shall be hot-dip galvanized in conformance with AASHTO M111 (ASTM A123).

Chord flange splice fastener assemblies shall conform to ASTM A325M, Type 1, and galvanized in accordance with AASHTO M232 (ASTM A153 or B695, Class 50, Type 1). Other fastener assemblies shall be as specified in Section 719.07, or as approved by the Engineer.

All ends of shafts open to the weather shall be fitted with an appropriate cast aluminum or galvanized cast iron cap secured in place with stainless steel set screws conforming to the requirements of ASTM F593.

All assemblies of each structure shall be permanently marked on the edge of the base plate or flange indicating steel specification, type and grade of base plate/flange and shaft, as well as the diameter and wall thickness of the shaft.

a. Light Standards, Mast Arm Poles, Strain Poles and Dual Purpose Poles Shafts shall be round, unless otherwise specified in the contract plans, and either tapered or of uniform cross section and shall be fabricated as a single continuous unit without splices, except that shafts with length over 12 m [40 ft] may be fabricated with one splice at approximately mid-height and dual purpose poles may be fabricated with a splice immediately above the mast arm attachment. The minimum wall thickness of the shafts shall be number 7 gauge. A hand hole of approximately 0.016 m² [25 in²] in area, reinforced to maintain the full design strength of the shaft, shall be provided with the hand hole center approximately 450 mm [18 in] above the base plate. Provisions for internal grounding shall be provided in a location accessible through the hand hole. A hole, fitted with a rubber grommet, shall be provided in the shaft to match the wire-way of the bracket arm or mast arm, except that strain poles shall

be provided with a wire inlet as shown on the standard details. On dual-purpose poles, a pull wire shall be provided for the luminaire.

b. Pedestal Poles Shafts shall be 100 mm [4 in] nominal ID, schedule 40 pipe without splices. The length of the pole plus the base shall be 3 m [10 ft], except that the length of poles supporting only pedestrian heads shall be 2.4 m [8 ft].

c. Bridges, Cantilever, and Butterfly Type Sign Support Structures The configuration of the foundations, bases, shafts, and trusses shall be of the Contractor's design as approved by the Engineer and shall use only material specified above.

720.04 Steel Mast Arm and Bracket Arm Material for mast arms and bracket arms shall be as specified in Section 720.03. Internal diameters, bents, joints, and attachments shall permit internal wiring in the upper member of the arms. Arms shall be hot dipped galvanized, both inside and outside, in conformance with AASHTO M111 (ASTM A123). All work shall conform to the applicable provisions of Section 504 - Structural Steel.

a. Mast Arms for Signals Mast arms may be of the single member or the truss type. Single member type mast arms shall be a single, straight or tapered, round member and may incorporate a maximum of 2 telescopic splices. Truss type mast arms shall be of a tapered design consisting of an upper and a lower member connected by vertical struts welded to form an integral unit. Mast arms shall be equipped with sturdy signal hangers and/or appropriate tenons for mounting the signal heads and shall have weatherproof wire inlets located close to the suspended signal heads.

b. Bracket Arms for Luminaires Bracket arms may be of the single member or the truss type. Single member type bracket arms shall be of the tapered upsweep design. Truss type bracket arms shall be of a tapered design consisting of an upper and lower member connected by a single vertical strut, welded to form an integral unit. Bracket arms shall be equipped with an appropriate tenon for the attachment of the luminaire.

720.05 High Mast Light Standard High mast light standards shall have a cross section that is either round or polygonal with not less than 12 sides, and shall have a uniform taper from the base to the top, except that an expanded base section may be used, if required, to accommodate the electrical and mechanical equipment. All work shall conform to the applicable provisions of Section 504 - Structural Steel.

For unpainted high mast structures, material for the shaft, base and attachments shall conform to the requirements ASTM A709M, Grade 345W [A709, Grade 50W] or ASTM A595, Grade C.

The base plate and reinforcing components of high mast poles shall be considered main load carrying members and shall comply with the requirements of Table A, Section 713.01 - Structural Steel. If applicable, the Contractor shall submit a proposed coating specification for approval by the Fabrication Engineer.

A Certificate of Compliance shall be provided for all material in accordance with the requirements of the General Statement of Division 700 - Materials.

720.06 Steel H-beam Posts Steel H-beam Posts shall conform to the requirements of ASTM A992/A992M. All work shall conform to the applicable provisions of Section 504 - Structural Steel. Steel shall be hot-dip galvanized in accordance with AASHTO M111 (ASTM A123). All steel hardware for use with H-beam poles shall be hot-dip galvanized in accordance with AASHTO M232 (ASTM A153 or B695, Class 50, Type 1).

720.07 Anchor Bolts Anchor bolts and nuts supplied for aluminum and/or steel supports shall conform to ASTM A449, Type 1, or ASTM F1554, Grade 55, both with a minimum yield strength of 380 Mpa [55 ksi]. Anchor bolts shall be supplied with 2 heavy hex nuts and 2 hardened washers and unless otherwise specified the anchor bolts shall have a 90° bend with a 150 mm [6 in] minimum leg length at the lower end. The anchor bolts, nuts and hardened washers shall be hot-dip galvanized in accordance with AASHTO M232 (ASTM A153 or B695, Class 50, Type 1). The bolt shall be zinc-coated 300 mm [12 in] from the exposed end, unless otherwise specified. If the anchor bolts are to be used with breakaway devices incorporating the function of a nut, for example, longitudinally grooved breakaway couplings, nuts or washers will not be required.

Alternate materials, grades, and designs may be used for the anchor bolts subject to approval of the Engineer.

720.08 U-Channel Posts Except as otherwise authorized, U-Channel posts for signs of less than 0.37 m² [4 ft²] in area, shall be fabricated of steel weighing 3.7 kg/m [2.5 lb/ft], and shall not be doubled-up. Aluminum U-channel posts having the same strength characteristics as steel U-channel posts may be used, subject to the approval of the Engineer. The steel U-channel posts shall be galvanized in accordance with AASHTO M111 (ASTM A123).

720.09 Wood Ornamental Light Standard Material for wood light standards shall be Western Red Cedar (*Rhuja Plicata*) or other species with equal or better decay resistance, approved by the Engineer.

The wood cross section shall be 250 mm by 250 mm [10 in by 10 in] minimum. The mounting height and depth of burial shall be as shown on the plans.

The following items shall be supplied, a 50 mm [2 in] slipfitter of corrosion resistant material of adequate length to support the luminaire, a sideplowed wire-way covered by a suitable flush filler strip to accommodate three, number 12 conductors, a pair of two-piece plinths for conduit entrance and splice box.

All bolts shall be hot-dip galvanized in accordance with AASHTO M232 (ASTM A153 or B695, Class 50, Type 1).

All parts of the wood light standard shall be prefitted and predrilled, holes shall be counterbored to conceal bolts and filled with mastic compound.

The wood light standard surface finish shall be as indicated on the plans.

720.10 Wood Utility Pole Wood Utility poles shall be Douglas Fir or Southern Yellow Pine, conforming to ANSI Standard Specification 05.1 and of the class and length as indicated on the plans.

Poles shall not have more than 180° twist in grain over the full length. Sweep shall be no more than 100 mm [4 inches]. Tops of poles shall be beveled.

Wood Utility poles shall be pressure treated, after fabrication, with creosote, pentachlorophenol (oil borne), pentachlorophenol liquefied petroleum gas solution or copper naphthenate (oil borne), in accordance with the latest AWWA Specification C4 for pressure treated wood poles.

720.11 Mast Arms for Wood Utility Poles All mast arms for wood Utility pole attachment shall be standard 50 mm [2 in] diameter pipe of specified length and shall include a mast arm head, universal joint, insulated wire inlet, tie rods, cross arm and mounting brackets. The vertical distance between the mast arm and point of attachment of the cross arm shall not be less than 40% of the mast arm length. All attachments for mast arm assemblies shall be designed to withstand stresses due to the mast arm and signal weights and wind loads generated by a 160 km/hr [100 mph] wind.

720.12 Wood Sign Posts Wood sign posts shall be rectangular, straight and sound timber, cut from live growing native spruce, hemlock, cedar or Douglas Fir trees, free from loose knots or other structurally weakening defects of importance, such as shake or holes and heart rot. A tolerance of 25 mm [1 in] in length and 6 mm [¼ in] in width or thickness is permitted in the dimensions of rectangular posts. They shall be sawn true and planed 4 sides. Nominal dimensions of rectangular posts shall be as given in the Contract documents.

Breakaway requirements 100 mm by 150 mm [4 in by 6 in] posts shall have two 38 mm [1½ in] diameter holes drilled perpendicular to traffic, one hole centered at 100 mm [4 in] above ground level and one centered at 460 mm [18 in] above ground level (posts shall be installed with the 150 mm [6 in] length parallel to the roadway); 150 mm by 150 mm [6 in by 6 in] posts shall have two 50 mm [2 in] diameter holes drilled perpendicular to traffic, one hole centered at 100 mm [4 in] above ground level and one centered at 460 mm [18 in] above ground level; 100 mm by 100 mm [4 in by 4 in] posts need not be modified.

When pressure treated wood sign posts are called for on the plans, the wood shall be Yellow Pine, Number 2 or better, .40 CCA, D4 S. The pressure treated wood shall meet AWWA Standard P-5 or Federal Standard TT-W-550. The treating process shall meet Federal Specification TT-W-571, or AWWA Commodity Standards as applicable.

SECTION 721 - BREAKAWAY DEVICES

721.01 Breakaway Devices Breakaway devices shall be capable of supporting all design loads and shall conform in all respects to the requirements of the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" and all applicable commentary. Breakaway Support Certification of both breakaway and structural adequacy shall be provided by the Manufacturer. Design calculations or test data of production samples to support certification shall be provided. Breakaway support components shall provide the same or greater structural strength as the support post or pole utilizing the breakaway device.

SECTION 722 - GEOTEXTILES

722.01 Stabilization/Reinforcement Geotextile The geotextile shall have property values expressed as Minimum Average Roll Value (MARV) in the weakest principal direction, which meet or exceed the values stated below. Sampling and conformance testing shall be in accordance with ASTM D4354. Geotextile product acceptance shall be based on ASTM D4759. Geotextile Storage and Handling requirements shall be based on ASTM D4873.

Woven and non-woven geotextiles are acceptable and must meet the following requirements:

Mechanical Property	Test Method ¹	MARV ²	
		Elongation ³	
		< 50%	≥ 50%
Grab Strength - N [lb]	D4632	1400 [315]	900 [202]
Sewn Seam Strength - N [lb]	D4632	1260 [283]	810 [182]
Tear Strength - N [lb]	D4533	500 [112]	350 [79]
Puncture Strength - N [lb]	D4833	500 [112]	350 [79]
Other Properties	Test Method ¹	Requirements	
Permittivity	D4491	0.05/sec ⁴	
Apparent Opening Size (AOS)	D4751	0.43 mm [0.017 in] (maximum) ⁵	
Ultraviolet Stability (Retained Strength)	D4355	50% after 500 hours of exposure	
Other Requirements	Test Method ¹		
Conformance	D4759		
Sampling for Testing	D4354		
Storage and Handling	D4873		

¹ASTM test method unless otherwise noted.

²Minimum Average Roll Value (MARV) unless otherwise noted.

³As determined in accordance with ASTM D4632.

⁴Permittivity of the geotextile should be greater than that of the soil. The Resident may also require the permeability of the geotextile to be greater than that of the soil.

⁵Maximum average roll value.

722.02 Drainage Geotextile The geotextile shall have property values expressed as Minimum Average Roll Value (MARV) in the weakest principal direction, which meet or exceed the values stated below. Sampling and conformance testing shall be in accordance with ASTM D4354. Geotextile product acceptance shall be based on ASTM D4759. Geotextile Storage and Handling requirements shall be based on ASTM D4873.

Both woven and nonwoven geotextiles are acceptable, however, no "slit-film" woven fabrics will be permitted. The geotextile must meet the following requirements:

Mechanical Property	Test Method ¹	MARV ²		
		Elongation ³		
		< 50%	≥ 50%	
Grab Strength - N [lb]	D4632	1100 [247]	700 [157]	
Sewn Seam Strength - N [lb]	D4632	990 [223]	630 [142]	
Tear Strength - N [lb]	D4533	400 [90] ⁴	250 [56]	
Puncture Strength - N [lb]	D4833	400 [90]	250 [56]	
Other Properties	Test Method ¹	Requirements Percent In-Situ Soil Passing 0.075 mm ⁵ [0.003 in]		
		<15	15 to 50	>50
		Permittivity	D4491	0.5/sec
Apparent Opening Size (AOS) ⁶ mm [in]	D4751	0.43 mm [0.017]	0.25 mm [0.010]	0.22 mm ⁷ [0.0087]
Ultraviolet Stability (Retained Strength)	D4355	50% after 500 hours of exposure		
Other Requirements	Test Method ¹			
Conformance	D4759			
Sampling for Testing	D4354			
Storage and Handling	D4873			

¹ASTM test method, unless otherwise noted.

²Minimum Average Roll Value (MARV) unless otherwise noted.

³As determined in accordance with ASTM D4632.

⁴The required MARV tear strength for woven monofilament geotextiles is 250 N [56 lb].

⁵Based on grain size analysis of in situ soil in accordance with AASHTO T88.

⁶Maximum average roll value.

⁷For cohesive soils with a plasticity index greater than 7, geotextile maximum average roll value for apparent opening size is 0.30 mm [0.012 in].

722.03 Erosion Control Geotextile The geotextile shall have property values expressed as Minimum Average Roll Value (MARV) in the weakest principal direction, which meet or exceed the values stated below. Sampling and conformance testing shall be in accordance with ASTM D4354. Geotextile product acceptance shall be based on ASTM D4759. Geotextile Storage and Handling requirements shall be based on ASTM D4873.

Both woven and non-woven geotextiles are acceptable, however, no "slit-film" woven fabrics will be permitted.

Woven Monofilament Erosion Control Geotextiles require Class 2 geotextile class designation. All other Erosion Control Geotextiles require Class 1 geotextile class designation.

The Erosion Control Geotextile class selection is appropriate for conditions of equal or less severity than either of the following:

- a. Armor layer stone weights do not exceed 100 kg [220 lb], stone drop height is less than 1 m [3 ft], and no aggregate bedding layer is required.
- b. Armor layer stone weighs more than 100 kg [220 lb], stone drop height is less than 1 m [3 ft], and the geotextile is protected by a 150 mm [6 in] thick aggregate bedding layer designed to be compatible with the armor layer. More severe applications require an assessment of geotextile survivability based on a field trial section and may require a geotextile of higher strength properties.

The Resident may specify a Class 2 geotextile based on one or more of the following:

- a. The Resident has found Class 2 geotextiles to have sufficient survivability based on field performance of the geotextile.
- b. The Resident has found Class 2 geotextiles to have sufficient survivability based on laboratory testing and visual inspection of a geotextile sample removed from a field test section constructed under anticipated field conditions.
- c. Armor layer stone weighs less than 100 kg [220 lb], stone drop height is less than 1 m [3 ft], and the geotextile is protected by a 150 mm [6 in] thick aggregate bedding layer designed to be compatible with the armor layer.
- d. Armor layer stone weights do not exceed 100 kg [220 lb] and stone is placed with a zero drop height.

The Class 2 geotextile must meet the requirements for drainage geotextile, except for the following:

Other Properties	Test Method	Requirements Percent In-Situ Soil Passing 0.075 mm [0.003 in]		
		<15	15 to 50	>50
Permittivity	D4491	0.7/sec	0.2/sec	0.1/sec

All other Erosion Control Geotextile applications that exceed the woven monofilament Erosion Control geotextile Class 2 criteria defined above require Class 1 geotextile class designation. The Class 1 geotextile must meet the requirements for Class 2 geotextile, except for the following:

Mechanical Property	Test Method	MARV	
		Elongation	
		< 50%	≥ 50%
Grab Strength - N [lb]	D4632	1400 [315]	900 [202]
Sewn Seam Strength - N [lb]	D4632	1260 [283]	810 [182]
Tear Strength - N [lb]	D4533	500 [112]	350 [79]
Puncture Strength - N [lb]	D4833	500 [112]	350 [79]

722.04 Separation Geotextile The geotextile shall have property values expressed as Minimum Average Roll Value (MARV) in the weakest principal direction, which meet or exceed the values stated below. Sampling and conformance testing shall be in accordance with ASTM D4354. Geotextile product acceptance shall be based on ASTM D4759. Geotextile Storage and Handling requirements shall be based on ASTM D4873.

Both woven and non-woven geotextiles are acceptable. The geotextile must meet the requirements of drainage geotextile, except for the following:

Other Properties	Test Method ¹	Requirements
Permittivity	D4491	0.02/sec
Apparent Opening Size (AOS)	D4751	0.60 mm [0.024 in](maximum)