

# DIVISION 700 - MATERIALS

## GENERAL STATEMENT MATERIALS CERTIFICATION LETTER

For all materials used in the work for which there is no specified acceptance 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 acceptance 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 shall be in conformity with the applicable drawings and/or standards for 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 3 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 at any time. When random verification samples are obtained from the Project, they shall be provided by the Contractor at no cost to the Department. Certified materials, which fail to meet specification requirements, may not be accepted and may require replacement with materials that do meet the specifications.

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.

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 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 T 27 except that the sample may be separated on the ½" screen. Testing as specified in AASHTO T 11 shall be performed on any materials for which there is a specification limit on the amount of material passing a 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 100 lb. All Work Zone Category 1 and Category 2 Devices shall meet NCHRP Report 350 and MUTCD 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/roadside\\_hardware.htm](http://safety.fhwa.gov/programs/roadside_hardware.htm).

## **SECTION 701 - STRUCTURAL CONCRETE RELATED MATERIAL**

701.01 **Portland Cement and Blended Hydraulic Cement** - Portland Cement for Cast-in-place concrete shall conform to the requirements of AASHTO M 85, Type II. Blended hydraulic cement for cast-in-place concrete shall conform to the requirements of AASHTO M 240, Type IS, Type IP, Type IL, or Type IT. Blended

hydraulic cement special property (HE), high early strength, will not be allowed for cast-in-place concrete.

Portland Cement for precast prestressed concrete shall conform to the requirements of AASHTO M 85, Type I, Type II, or Type III. Blended hydraulic cement for precast concrete shall conform to the requirements of AASHTO M 240, Type IS, Type IP, Type IL, or Type IT. Blended hydraulic cement special property (HE), high early strength, will be allowed for precast concrete.

Portland Cement for precast concrete shall conform to the requirements of AASHTO M 85, Type I, Type II, or Type III. Blended hydraulic cement for precast concrete shall conform to the requirements of AASHTO M 240, Type IS, Type IP, Type IL, or Type IT. Blended hydraulic cement special property (HE), high early strength, will be allowed for precast concrete.

**Portland Cement** - A hydraulic cement produced by pulverizing Portland Cement clinker, and usually containing calcium sulfate.

**Blended Hydraulic Cement** - A hydraulic cement consisting of two or more inorganic constituents (at least one of which is not Portland Cement or Portland Cement clinker) which separately or in combination contribute to the strength-gaining properties of the cement (made with or without other constituents, processing additions and functional additions, by intergrinding or other blending).

Only one brand of cement shall be used on any one Contract unless otherwise permitted, in writing, by the Resident. The cement shall be completely protected from rain and moisture during storage. Partially set cement or cement that contains caked lumps shall not be used.

The Contractor shall arrange for the cement supplier to provide a Manufacturer's Certification (Mill Test Report) for all cement materials furnished for use on the Project. Reports shall include all mandatory and optional requirements specified in AASHTO M 85 or AASHTO M 240 including any processing additions. Reports shall represent the cement incorporated into the Project and reports shall be supplied, at a minimum, on a monthly basis. Reports shall be submitted to the Department's Materials Testing Engineer.

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 in accordance with the requirements of AASHTO T 26. 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 Chemical Admixtures** - Air-entraining admixtures shall be tested by AASHTO Product Evaluation & Audit Solutions and conform to the requirements of AASHTO M 154.

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

- 701.04 **Water Reducing Chemical Admixtures** - Water reducing admixtures shall be tested by AASHTO Product Evaluation & Audit Solutions and conform to the requirements of AASHTO M 194, Type A.

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

- 701.0401 **High Range, Water Reducing, Chemical Admixture** - High range, water-reducing admixture, commonly referred to as both high range-water-reducers and/or superplasticizers, shall be AASHTO Product Evaluation & Audit Solutions tested and conform to the requirements of AASHTO M 194, Type F.

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

- 701.05 **Set-retarding Chemical Admixtures** - Set-retarding admixtures shall be tested by AASHTO Product Evaluation & Audit Solutions and conform to the requirements of AASHTO M 194, Types B or D or G.

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

- 701.0501 **Accelerating, Chemical Admixtures** - Accelerating admixtures shall be tested by AASHTO Product Evaluation & Audit Solutions and conform to the requirements of AASHTO M 194, Types C or E.

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

- 701.06 **Curing Materials** - Sheet materials for curing concrete shall conform to the requirements of AASHTO M 171. Burlap cloth shall conform to the requirements of AASHTO M 182 Class 3, 10 oz/yd. Liquid membrane-forming compounds shall conform to the requirements of AASHTO M 148 and shall be one of the products listed on the Maine Department of Transportation's Qualified Products 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.

- 701.10 **Coal Ash and Natural Pozzolans** - Coal Ash shall conform to the chemical and physical requirements of AASHTO M 295, Class F or Class C coal ash.
- Natural pozzolans shall conform to the chemical and physical requirements of AASHTO M 295, Class N.
- Coal ash and natural pozzolans shall be stored in weather tight silos. All silos shall be completely empty and clean before material is deposited therein, unless the silo already contains material of the same type and properties.
- 701.11 **Calcium Nitrite Solution, Chemical Admixture** - Calcium nitrite solutions shall be tested by AASHTO Product Evaluation & Audit Solutions and conform to the requirements of ASTM C1582. 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 Qualified Products List.
- 701.12 **Silica Fume** - The silica fume material for use in Portland Cement Concrete shall conform to the chemical and physical requirements of AASHTO M 307 and be one of the products listed on the Maine Department of Transportation's Qualified Products List.
- The Contractor shall arrange for the silica fume supplier to provide a Manufacturer's Certification (Mill Test Report) for all silica fume materials furnished for use on the Project. Reports shall include all mandatory and optional requirements specified in AASHTO M 307. Reports shall represent the silica fume incorporated into the Project and reports shall be supplied, at a minimum, on a monthly basis. Reports shall be submitted to the Department's Materials Testing Engineer.
- 701.13 **Slag Cement** - Slag cement shall conform to the chemical and physical requirements for Grade 100 or 120 as listed in AASHTO M 302.
- Slag cement shall be stored in weather tight silos. All silos shall be completely empty and clean before material is deposited therein, unless the silo already contains material of the same type and properties.
- The Contractor shall arrange for the slag cement supplier to provide a Manufacturer's Certification (Mill Test Report) for all slag cement materials furnished for use on the Project. Reports shall include all mandatory and optional requirements specified in AASHTO M 302 including any processing additions. Reports shall represent the slag cement incorporated into the Project and reports shall be supplied, at a minimum, on a monthly basis. Reports shall be submitted to the Department's Materials Testing Engineer.

## SECTION 702 - BITUMINOUS MATERIAL

702.01 **Asphalt Cement** - Performance-Graded Asphalt Binder (PGAB) that has not been modified with polymer shall conform to the requirements of AASHTO M 320. Polymer modified binder shall meet the requirements of AASHTO M 332 and AASHTO R 92. Performance-Graded Asphalt Binder shall not contain re-refined engine oil bottoms (REOB).

The Contractor shall arrange for the Supplier to furnish the following items to the Department's Asphalt Pavement Engineer:

- a. A Quality Control Plan that conforms to the requirements of AASHTO R 26 "Certifying Suppliers of Performance-Graded Asphalt Binders" and
- b. A 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 Departments Asphalt Pavement Engineer.

The Contractor shall give the supplier sufficient notice of orders to permit testing and certification. Material not certified will not be accepted for use.

Deliveries of asphalt materials shall be accompanied by a Bill of Lading containing the information required under Section 108.1.3 f. The Bill of Lading 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 non-bituminous components added to the binder prior to the sampling point for binder certification shall be included on the asphalt binder Certificate of Analysis identifying their presence. All non-bituminous components added after the certification sampling point and prior to transport shall be included on the Bill of Lading. All non-bituminous components added to the binder at the HMA plant shall be identified on

the mix plant documentation and accompanied by test results and certification showing the effect of the additives introduced, if any.

702.04 **Emulsified Asphalt** - Emulsified Asphalt shall conform to the requirements of AASHTO M 140. Cationic emulsified asphalt shall conform to the requirements of AASHTO M 208. Anionic emulsified asphalt Grade RS-1h shall conform to the requirements in the following table:

Type Grade	Rapid-Setting RS-1h	
	min	max
<b>Tests on Emulsions</b>		
Viscosity, Saybolt Furol at 25°C SFS	20	100
Storage Stability test, 24-h, % <sup>A</sup>	-	1.0
Demulsibility, 35 ml, 0.02 N CaCl <sub>2</sub> , %	60	-
Sieve Test, % <sup>A</sup>	-	0.10
Residue by distillation, %	55	-
Tests on Residue from Distillation Test	min	max
Penetration, 25°C 100g, 5 s	40	90
Ductility, 25°C 5 cm/min, cm	40	-
Solubility in trichloroethylene or n-propyl bromide, %	97.5	-
<sup>A</sup> This requirement is waived if successful application of material has been achieved in the field.		

Use of all emulsified asphalt shall comply with all Department of Environmental Protection (DEP) regulations regarding maximum amount of oil distillate, seasonal limitations, etc.

For emulsified asphalts, the Contractor shall arrange for the Supplier to furnish the following item to the Department's Materials Testing Engineer.

A CERTIFICATE OF ANALYSIS for all asphalt emulsion 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 or batch for each grade/type of emulsion. 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 Department's Materials Testing Engineer.

Deliveries of emulsion 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.

702.05 **Temperature Application Range, °F**

<b>Type and Grade</b>	<b>Spray</b>	<b>Mix</b>
RS-1	50 to 125	50 to 125
RC 70	80 to 150	80 to 150
RC 250	82 to 175	80 to 150
RC 800	160 to 225	135 to 185
RC 3000	200 to 275	185 to 225
MC 30	50 to 120	50 to 120
MC 70	80 to 150	80 to 150
MC 250	100 to 200	100 to 210
MC 800	185 to 260	200 to 250
MC 3000	230 to 275	200 to 250
All emulsions	50 to 160	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 60°F.

Emulsified Asphalts	Asphalts (ASTM D1250)								
	All Types And Grades	Temp °F	Sp. Gr. 0.966+	Sp. Gr. 0.850	Temp °F	Sp. Gr. 0.966+	Sp. Gr. 0.850	Temp °F	Sp. Gr. 0.966+
1	50	1.0035	1.0040	150	.9689	.9647	250	.9352	.9268
1	55	1.0017	1.0020	155	.9672	.9628	255	.9336	.9249
1.0000	60	1.0000	1.0000	160	.9655	.9609	260	.9319	.9231
.9988	65	.9983	.9980	165	.9638	.9589	265	.9302	.9212
.9975	70	.9965	.9960	170	.9621	.9570	270	.9286	.9194
.9962	75	.9948	.9940	175	.9604	.9551	275	.9269	.9175
.9950	80	.9930	.9921	180	.9587	.9532	280	.9253	.9157
.9938	85	.9913	.9901	185	.9570	.9513	285	.9236	.9138
.9925	90	.9896	.9881	190	.9553	.9494	290	.9220	.9120
.9912	95	.9878	.9861	195	.9536	.9475	295	.9204	.9102
.9900	100	.9861	.9842	200	.9520	.9456	300	.9187	.9083
.9988	105	.9844	.9822	205	.9503	.9437	305	.9171	.9065
.9875	110	.9826	.9803	210	.9486	.9418	310	.9154	.9047
.9862	115	.9809	.9783	215	.9469	.9399	315	.9138	.9029
.9850	120	.9792	.9763	220	.9452	.9380	320	.9122	.9010
.9338	125	.9775	.9744	225	.9436	.9361	325	.9105	.8992
.9825	130	.9758	.9725	230	.9419	.9343	330	.9089	.8974
.9812	135	.9740	.9705	235	.9402	.9324	335	.9073	.8956
.9800	140	.9723	.9686	240	.9385	.9305	340	.9057	.8938
.9788	145	.9706	.9666	245	.9369	.9286	345	.9040	.8920
.9775	150	.9689	.9647	250	.9352	.9268	350	.9024	.8902

702.07 **Removed**

702.08 **Removed**

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 M 190 or of AASHTO M 320, Table 1, for PG 64-28 or PG 58-28.

702.10 **Removed**

702.11 **Removed**

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 tested for qualities in Table 1. Fine aggregate unable to meet quality requirements of Table 1 shall be rejected or take corrective actions to meet quality requirements.

**TABLE 1**

Description	Test Method	Specification Limit
Organic Impurities	AASHTO T 21	Laboratory Designation Plate III, max
Sand Equivalent	AASHTO T 176	75, min.
Gradation	AASHTO T 27 & T 11	Table 2 below
Fineness Modulus	*	2.26 to 3.14
Absorption	AASHTO T 84	2.3%, max
ASR, no mitigation	Standard Specification 703.0201	
ASR, with mitigation (When applicable)	Standard Specification 703.0201	
*	The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages of material by weight retained on the following sieves: Nos. 4, 8, 16, 30, 50, 100 and dividing by 100.	

**TABLE 2**

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
3/8"	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10
No. 200	0-5.0

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. Each pile of a designated coarse aggregate grading, size, or blended material, shall be stored in separate stockpiles and not be mixed with adjacent stockpiles.

All coarse aggregate for concrete shall be tested for qualities in Table 1. Coarse aggregate unable to meet quality requirements of Table 1 shall be rejected or take corrective actions to meet quality requirements. (See Table 2 on next page.)

**TABLE 1**

Description	Test Method	Specification Limit
Flat, Elongated, or Flat & Elongated Particles*	ASTM D4791 (Dimensional Ratio 1:5)	15%, max (by weight)
Micro-Deval or LA Wear	AASHTO T 327 or AASHTO T 96	18.0%, max or 40%, max
Gradation**	AASHTO T 27 & T 11	Table 2 below
Absorption	AASHTO T 85 (modified for sample weight)	2.0% (by weight)
ASR, no mitigation	Standard Specification 703.0201	
ASR, with mitigation (When applicable)	Standard Specification 703.0201	
* **	Samples shall represent the composite blend, of the proposed mix design, retained on the 3/8" sieve. Gradations shall conform to specified grading designation and shall be well graded between the limits specified.	

**TABLE 2**

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves						
	S	A	AA	SP-1-7	SP-1-78	SP-2-8	SP-2-89
Aggregate Size	1½"	1"	¾"	½"	½"	⅜"	⅜"
2"	100						
1½"	95-100	95-100					
1"	-	-	100				
¾"	35-70	-	90-100	100	100		
½"	-	25-60	-	90-100	90-100	100	100
⅜"	10-30	-	20-55	40-70	40-75	85-100	90-100
No. 4	0-5	0-10	0-10	0-15	5-25	10-30	20-55
No. 8	-	0-5	0-5	0-5	0-10	0-10	5-30
No. 16	-	-	-	-	0-5	0-5	0-10
No. 50	-	-	-	-	-	-	0-5
No. 200*	0-1.5	0-1.5	0-1.5	0-1.5	0-1.5	0-1.5	0-1.5
* This limit will be 0-2.0 for Department production samples. Yearly quality samples will be held to 0-1.5.							

703.0201 **Alkali Silica Reactive Aggregates** - All coarse and fine aggregates proposed for use in concrete shall be tested for Alkali Silica Reactivity (ASR) potential. All coarse and fine aggregates shall meet the specification limits of at least one test method below in Table 1.

**TABLE 1**

Test Method & Duration	Specification Limit	Minimum Testing Frequency
AASHTO T 303 (ASTM C1260), 16 Days from casting	0.06%, max	Every 5 years
ASTM C1567, 16 Days from casting	0.06%, max	Every 5 years
ASTM C1293, 1 year	0.04%, max	Every 6 years
AASHTO TP 144, 21 Days	Nonreactive	Every 5 years

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 Ash meeting the requirements of AASHTO M 295
- b. Slag Cement (Grade 100 or 120) meeting the requirements of AASHTO M 302
- c. Densified Silica Fume meeting the requirements of AASHTO M 307
- d. Lithium-based admixtures
- e. Metakaolin

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.

The Department may reject aggregate sources with known field history of ASR reactions, regardless of test results above.

- 703.03 **Combined Aggregate Grading for Concrete** - The combined gradation of the fine and coarse aggregates when mathematically blended using the mix design percentages shall conform to the requirements of the following table for the size or sizes designated and shall be well graded between the limits specified.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves						
	S	A	AA	SP-1-7	SP-1-78	SP-2-8	SP-2-89
Aggregate Size	1½"	1"	¾"	½"	½"	⅜"	⅜"
2"	100						
1½"	95-100	100					
1"	80-100	95-100	100				
¾"	55-90	90-100	93-100	100	100		
½"	45-80	55-80	60-90	90-100	90-100	100	100
⅜"	40-65	40-65	50-80	55-85	65-90	90-100	90-100
No. 4	35-55	35-55	35-60	30-60	40-70	45-75	50-80
No. 8	25-53	28-50	30-55	25-55	30-65	35-65	35-75
No. 16	15-40	18-45	19-45	18-50	20-55	20-55	20-55
No. 30	7-30	9-30	10-33	8-32	10-38	10-38	10-40
No. 50	3-14	4-14	4-16	3-16	4-20	4-20	4-20
No. 100	0-6	0-6	0-6	0-6	0-7	0-8	0-8
No. 200	0-3.5*	0-3.5*	0-3.5*	0-3.5*	0-3.5*	0-3.5*	0-3.5*
* The percent passing the No. 200 sieve shall not exceed 6.0% for any fine aggregate. The percent passing the No. 200 sieve shall not exceed 2.0% for any single coarse aggregate. The percent passing the No. 200 sieve shall not exceed 4.0% for the combined gradation of self-consolidating concrete (SCC) mix designs.							

- 703.04 **Removed**

- 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 aggregate shall meet the grading requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
⅜"	85-100
No. 200	0-5.0

703.06 **Aggregate for Base and Subbase** - The following shall apply to Sections (a.) and (c.) below. The material shall have a Micro-Deval value of 25.0 or less as determined by AASHTO T 327. If the Micro- Deval value exceeds 25.0, the Washington State Degradation DOT Test Method T113, Method of Test for Determination of Degradation Value (January 2009 version) shall be performed, except that the test shall be performed on the portion of the sample that passes the ½ in sieve and is retained on the No. 10 sieve. If the material has a Washington Degradation value of less than 15, the material shall be rejected.

The material used in Section (b.) below shall have a Micro-Deval value of 25.0 or less as determined by AASHTO T 327. If the Micro-Deval value exceeds 25.0 the material may be used if it does not exceed 25% loss on AASHTO T 96, Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

Recycled Asphalt Pavement (RAP) shall not be used for or blended with aggregate base or subbase.

- a. Aggregate for base, Type A and B shall be crushed ledge 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 3" sieve shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Type A	Type B
½"	45-70	35-75
¼"	30-55	25-60
No. 40	0-20	0-25
No. 200	0-6.0	0-6.0

At least 50% by weight of the material retained on the No. 4 sieve shall have at least one fractured face as tested by AASHTO T 335.

Type A aggregate for base shall only contain particles of rock that will pass the 2" square mesh sieve.

Type B aggregate for base shall only contain particles of rock that will pass the 4" square mesh sieve.

- b. Aggregate for base, Type C shall be crushed ledge or crushed gravel of hard durable particles free from vegetable matter, lumps or balls of clay

and other deleterious substances. The material shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
	Type C
4"	100
3"	90-100
2"	75-100
1"	50-80
1/2"	30-60
No. 4	15-40
No. 200	0-6.0

At least 50% by weight of the material coarser than the No. 4 sieve shall have at least one fractured face as tested by AASHTO T 335.

- c. 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 3" sieve shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Type D	Type E
1/2"	35-80	
1/4"	25-65	25-100
No. 40	0-30	0-50
No. 200	0-7.0	0-7.0

Type D aggregate for subbase gravel may contain up to 50% by weight Recycled Concrete Aggregate (RCA). When RCA is used, the portion of the resulting blend of gravel and RCA retained on a 1/2" square mesh sieve shall contain a total of no more than 5% by weight of other recycled materials such as brick, concrete masonry block, or asphalt pavement as determined by visual inspection.

RCA shall be substantially free of wood, metal, plaster, and gypsum board as defined in Note 9 in Section 7.4 of AASHTO M 319. RCA shall also be free of all substances that fall under the category of solid waste or hazardous materials.

Aggregate for subbase shall not contain particles of rock which will not pass the 6" square mesh sieve.

703.07 **Aggregates for HMA Pavements** - Coarse 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 No. 4 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. Coarse aggregate shall not exceed an absorption of 2.0% by weight as determined by AASHTO T 85.

Fine aggregate, material that passes the No. 4 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 2.3% by weight as determined by AASHTO T 84.

All individual aggregates for hot mix asphalt pavements shall meet Table 3 requirements (excluding LCP) unless otherwise noted. The Department reserves the right to sample and test the aggregate for any of the following properties at any time:

**TABLE 3: AGGREGATE CONSENSUS PROPERTIES CRITERIA**

Estimated Traffic, Million 18 kip ESALs	AASHTO T 335 (minimum %)	AASHTO T 304 Method A**	ASTM D4791 Method B	AASHTO T 176	Aggregate shall meet at least one of these:		
					AASHTO T 327	AASHTO T 96	WSDOT T 113*
< 3.0	75/60	≥ 40%	≤ 10%	≥ 45	≤ 18.0%	≤ 40%	≥ 30
3.0 to < 10	90/80	≥ 45%		≥ 50		≤ 35%	
≥ 10	95/90			≤ 30%		N/A	
*	As determined by Washington State DOT Test Method T 113, Method of Test for Determination of Degradation Value except that the reported degradation value will be the result of testing a single composite specimen from that portion of the sample that passes the ½" sieve and is retained on the No. 10 sieve.						
**	Property will be evaluated on a mix design basis by calculating a weighted average based upon individual aggregate values (weighted average by the percentage proportion of the aggregate within the design).						

- **AASHTO T 335** - “90/80” denotes that 90% of the coarse aggregate has one fractured face and 80% has two fractured faces.
- **AASHTO T 304** - Criteria are presented as percent air voids in loosely compacted fine aggregate, (U).
- **ASTM D4791** - 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 Department to change sources.

703.08 **Recycled Asphalt Pavement** - Recycled asphalt pavement shall consist of salvaged asphalt materials from milled pavements or production waste that has been processed before use to meet the requirements of the job mix formula. It shall be free of winter sand, granular fill, construction debris, or other materials not generally considered asphalt pavement.

703.081 **RAP for Asphalt Pavement** - Recycled Asphalt Pavement (RAP) may be introduced into hot-mix asphalt pavement at percentages approved by the Department according to the MaineDOT Policies and Procedures for HMA Sampling and Testing.

If approved by the Department, the Contractor shall provide documentation stating the source, test results for average residual asphalt content, and stockpile gradations showing RAP materials have been sized to meet the maximum aggregate size requirements of each mix designation. The Department will obtain samples for verification and approval prior to its use.

The maximum allowable percent of RAP shall be determined by the asphalt content, the percent passing the 0.075 mm sieve, the ratio between the percent passing the 0.075 mm sieve and the asphalt content, and Coarse Micro-Deval loss values as tested by the Department.

The maximum percentage of RAP allowable shall be the lowest percentage as determined according to Table 4 on next page:

**TABLE 4: MAXIMUM PERCENT RAP ACCORDING TO TEST RESULTS**

Classification	Maximum RAP Percentage Allowed	Asphalt content standard deviation	Percent passing 0.075 mm sieve standard deviation	Percent passing 0.075 mm sieve / asphalt content ratio	Residual aggregate M-D loss value
Class III	10%	≤ 1.0	N/A	≤ 4.0	≤ 18
Class II	20%	≤ 0.5	≤ 1.0	≤ 2.8	
Class I	30%	≤ 0.3	≤ 0.5	≤ 1.8	

The Department will monitor RAP asphalt content and gradation during production by testing samples from the stockpile at approximately 15,000 T intervals (in terms of mix production). The allowable variance limits (from the numerical average values used for

mix designs) for this testing are determined based upon the maximum allowable RAP percentage and are shown below in

**TABLE 5 - RAP VERIFICATION LIMITS**

<b>Classification</b>	<b>Asphalt content (compared to aim)</b>	<b>Percent passing 0.075 mm sieve (compared to aim)</b>
Class III	± 1.5	± 2.0
Class II	± 1.0	± 1.5
Class I	± 0.5	± 0.7

For specification purposes, RAP will be categorized as follows:

- **Class III** – A maximum of 10.0% of Class III RAP may be used in any base, intermediate base, surface, or shim mixture. A maximum of 20.0% of Class III RAP may be used in hand-placed mixes for item 403.209.
- **Class II** – A maximum of 20.0% Class II RAP in any base, binder, surface, or shim course.
- **Class I** – A maximum of 20.0% Class I RAP may be used in any base, intermediate base, surface, or shim mixture without requiring a change to the specified asphalt binder. A maximum of 30.0% Class I RAP may be used in in any base or intermediate base mixture provided that a PG 58-28 or PG 58-34 asphalt binder is used. A maximum of 30.0% Class I RAP may be used in any surface or shim mixture provided that PG 58-34 asphalt binder is used. Mixtures exceeding 20.0% Class I RAP must be evaluated and approved by the Department.

The Contractor may use up to two different RAP sources in any one mix design. The total RAP percentage of the mix shall not exceed the maximum allowed for the highest classification RAP source used (i.e. if a Class I & Class III used, total RAP must not exceed 30.0%). The blended RAP material must meet all the requirements of the classification for which the RAP is entered (i.e. 10% Class III with 20% Class I, blend must meet Class I criteria). The Department may take belt cuts of the blended RAP to verify the material meets these requirements. If the Contractor elects to use more than one RAP source in a design, the Contractor shall provide an acceptable point of sampling blended RAP material from the feed belt.

In the event that RAP source or properties change, the Contractor shall notify the Department of the change and submit new documentation stating the new source or properties a minimum of 72 hours prior to the change to allow for obtaining new samples and approval.

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, including RAP aggregate will meet the grading requirements of the following table:

**AGGREGATE GRADATION CONTROL POINTS**

<b>Nominal Maximum Aggregate Size---Control Points (Percent Passing)</b>						
<b>Sieve Designation</b>	<b>Type 25 mm</b>	<b>Type 19 mm</b>	<b>Type 12.5 mm</b>	<b>Type 9.5 mm</b>	<b>Type 9.5 mm Thin Lift Mixture (TLM)</b>	<b>Type 4.75 mm</b>
<b>Percent By Weight Passing - Combined Aggregate</b>						
37.5 mm	100					
25 mm	90-100	100				
19 mm	-90	90-100	100			
12.5 mm	-	-90	90-100	100	100	100
9.5 mm	-	-	-90	90-100	95-100	95-100
4.75 mm	-	-	-	-90	60-95	80-100
2.36 mm	19-45	23-49	28-58	32-67	47-65	40 - 80
1.18 mm	-	-	-	-	-	-
0.60 mm	-	-	-	-	-	-
0.30 mm	-	-	-	-	-	-
0.075 mm	2.0-6.0	2.0-6.0	2.0-6.0	2.0-7.0*	2.0-7.0*	2.0-7.0
* For 9.5 mm nominal maximum aggregate size mixtures, the maximum design aim for the percent passing the 75 µm sieve is 6.5%.						

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. If this item is to be used underneath pavement, it must have a Micro-Deval value of 20.0 or less as determined by AASHTO T 327. If the Micro-Deval value exceeds 20.0, the material may be used if it does not exceed 25% loss on AASHTO T 96, Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los

Angeles Machine. The aggregate shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Untreated Aggregate Surface Course	
	Type A	Type B
1"	95-100	95-100
¾"	90-100	90-100
No. 4	40-65	10-45
No. 10	10-45	10-35
No. 200	0-7.0	0-6.0

703.11 **Aggregate for Shoulder** - The gradation of that portion passing a 3" sieve shall meet the gradation requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves		
	*Paved or Unpaved Lifts 4" or Greater	Paved Lifts < 4"	Unpaved Lifts < 4"
1"	-	90-100	90-100
¼"	25-70	25-100	25-70
No. 40	5-30	5-50	5-30
No. 200	2.0-10.0	2.0-10.0	2.0-10.0
* Shall not contain particles larger than 6" 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 have a Micro-Deval value of 18% or less as determined by AASHTO T 327. The aggregate shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1"	100
¾"	60-90
½"	10-35
⅜"	2-15
No. 4	0-5

703.13 **Crushed Stone ¾"** - Aggregate for Crushed Stone ¾" shall be of quarried stone and have a Micro-Deval value of 18.0% or less as determined by AASHTO T 327. The aggregate shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1"	100
¾"	90-100
½"	20-55
⅜"	0-15
No. 4	0-5

703.14 **Removed**

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 M 17.

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 including material currently or previously contaminated by chemical, radiological, or biological agents unless the material is from a DOT Project and authorized by DEP for use.

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 T 180, 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, frozen material and other deleterious substances. The gradation of that portion passing a 3" sieve shall meet the gradation requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Material for Underwater Backfill	Material for Embankment Construction
No. 40	0 - 70	0 - 70
No. 200	0 - 7.0	0 - 20.0

Granular borrow for underwater backfill shall contain no particles or fragments larger than 3". Granular borrow for embankment construction 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 6". The gradation of that portion passing a 3" sieve shall meet the gradation requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
¼"	0 - 70
No. 200	0 - 10.0

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 3 ft in its greatest dimension.

703.22 **Underdrain Backfill Material** - Material for underdrain shall be free from organic matter, frozen material and shall conform to the following tables:

Type B material shall conform to the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1"	95-100
½"	75-100
No. 4	50-100
No. 20	15-80
No. 50	0-15
No. 200	0-5.0

Type C material shall conform to the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1"	100
¾"	90-100
⅜"	0-75
No. 4	0-25
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
6"	90-100
1½"	0-40
No. 4	0-5

- 703.25 **Stone Fill** - Stones for stone fill shall consist of hard, sound, durable rock that will not disintegrate by exposure to water or weather. Stone for stone fill shall be angular and rough. Rounded, subrounded, or long thin stones will not be allowed. Stone for stone fill may be obtained from quarries or by screening oversized rock from earth borrow pits. The maximum allowable length to thickness ratio will be 3:1. The minimum stone size (10 lb) shall have an average dimension of 5". The maximum stone size (500 lb) shall have a maximum dimension of approximately 36". Larger stones may be used if approved by the Resident. Fifty percent of the stones by volume shall have an average dimension greater than 12" (200 lb).
- 703.26 **Plain and Hand Laid Riprap** - Stone for riprap shall consist of hard, sound durable rock that will not disintegrate by exposure to water or weather. Stone for riprap shall be angular and rough. Rounded, subrounded or long thin stones will not be allowed. The maximum allowable length to width ratio will be 3:1. Stone for riprap may be obtained from quarries or by screening oversized rock from earth borrow pits. The minimum stone size (10 lb) shall have an average dimension of 5". The maximum stone size (200 lb) shall have an average dimension of approximately 12". Larger stones may be used if approved by the Resident. 50% of the stones by volume shall have an average dimension greater than 9" (50 lb).
- 703.27 **Stone Blanket** - Stones for stone blanket shall consist of sound durable rock that will not disintegrate by exposure to water or weather. Stone for stone blanket shall be angular and rough. Rounded or subrounded stones will not be allowed. Stones may be obtained from quarries or by screening oversized rock from earth borrow pits. The minimum stone size (300 lb) shall have minimum dimension of 14", and the maximum stone size (3,000 lb) shall have a maximum dimension of approximately 66". Fifty percent of the stones by volume shall have average dimension greater than 24" (1,000 lb).
- 703.28 **Heavy Riprap** - Stone for heavy riprap shall consist of hard, sound, durable rock that will not disintegrate by exposure to water or weather. Stone for heavy riprap shall be angular and rough. Rounded, subrounded, or thin, flat stones will not be allowed. The maximum allowable length to width ratio will be 3:1. Stone for heavy riprap may be obtained from quarries or by screening oversized rock from earth borrow pits. The minimum stone size (500 lb) shall have minimum dimension of 15", and at least 50% of the stones by volume shall have an average dimension greater than 24" (1,000 lb).

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
12"	90-100
4"	0-15

The size of any stone shall not exceed 18" when measured along its longest axis.

703.30 **Removed**

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 (see Table on next page):

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
2½"	100
2"	95-100
1"	0-30

703.32 **Definitions (ASTM D 2488, Table 1)**

- **Angular** - Particles have sharp edges and relatively plane sides with unpolished surfaces
- **Subrounded** - Particles have nearly plane sides but have well-rounded corners and edges
- **Rounded** - Particles have smoothly curved sides and no edges

703.33 **Stone Ballast Aggregate** - for stone ballast shall be clean and graded crushed stone aggregate with a hard, dense angular particle structure providing sharp corners and cubicle fragments with prime consideration for drainage efficiency.

The material retained on the ¾" sieve shall contain not more than 5%, by weight of flat and elongated particles when performed in accordance with test method ASTM D 4791, Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate, using a dimensional ratio of 1:5.

The material shall have an absorption no greater than 1.5% by weight and a bulk specific gravity of 2.60 or greater as determined in accordance with AASHTO T 85 modified for weight of sample.

The material shall not exceed 30% loss on ASTM C535, Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

## 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, Catch Basin and Manhole	AASHTO M 91, Grade MS or SM
Building	AASHTO M 114, Grade SW

704.02 **Brick for Paving** - Brick for paving shall conform to the requirements of AASHTO M 114 (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 6,000 psi.
- c. The modulus of rupture shall not be less than 1,000 psi.
- d. The bricks shall be No. 1, water struck type for paving.

The bricks shall be 2¼" by 3¾" by 8" with permissible variations not to exceed 1/16" in depth, 1/8" in width and ¼" 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.

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 M 213.

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 M 85, Type II or IIA.

The sand shall meet the requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Joints Thicker Than ½"	Joints ½" or Thinner
¾"	100	-
¼"	-	100
No. 4	95-100	-
No. 8	70-95	85-100
No. 16	45-80	60-90
No. 30	25-55	35-70
No. 50	10-30	15-45
No. 100	2-10	0-15
No. 200	0-5.0	0-5.0

When necessary, material retained on the No. 4 sieve may be removed.

The sand shall be subjected to the colorimetric test for organic impurities, AASHTO T 21, 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 Watertight Gaskets** - Flexible gaskets, either rubber or plastic, shall conform to ASTM C990.

## SECTION 706 - NON-METALLIC PIPE

- 706.01 **Removed**

- 706.02 **Reinforced Concrete Pipe** - This pipe shall conform to the requirements of AASHTO M 170M/M 170. Elliptical pipe shall conform to the requirements of AASHTO M 207M/M 207. 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 M 206M/M 206.

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.

Fine and coarse aggregate sources shall meet the Alkali Silica Reactivity (ASR) requirements of Section 703.0201.

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

- 706.03 **Removed**

- 706.04 **Removed**

- 706.05 **Removed**

- 706.06 **Corrugated Polyethylene Pipe for Underdrain, Option I, and Option III Culvert Pipe** - Six inch diameter underdrain pipe and fittings shall conform to the requirements of AASHTO M 252, slot-perforated. Twelve to 60" diameter, Option I/III shall conform to the requirements of AASHTO M 294 Type S. Pipe to be used for Underdrain Type C shall meet the requirements of AASHTO M 294, Type SP and have Class I perforations. All polyethylene pipe shall be smooth lined and shall meet the pipe stiffness requirements shown on the Standard Details. The manufacturing plants of polyethylene pipe shall participate annually in the AASHTO Product Evaluation & Audit Solutions process for plastic pipe and resins which includes audits by the AASHTO Re:Source. Plants shall be listed as "Compliant" on the AASHTO Product Evaluation & Audit Solutions website and take immediate corrective action for any deficiencies found during audits. Continued compliance with all elements of the AASHTO Product Evaluation & Audit Solutions/ AASHTO Re:Source program and the Maine DOT manufactured Materials Verification Program will be required in order to continue supplying product to the Maine DOT.
- 706.07 **Removed**
- 706.08 **PVC (Polyvinylchloride) Pipe** - This pipe and fittings shall conform to the requirements of AASHTO M 278. 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 M 278 or ASTM F949 for 6" underdrain and AASHTO M 278 for underdrain larger than 6" diameter.
- 706.10 **Corrugated Polypropylene Pipe for Option I and Option III Culvert Pipe** - Option I/III pipe and fittings shall conform to the requirements of AASHTO M 330 Type S (dual wall) or Type D (triple wall). All polypropylene pipe shall be smooth lined and shall meet the pipe stiffness requirements of AASHTO M 330. The manufacturing plants of polypropylene pipe shall participate annually in the AASHTO Product Evaluation & Audit Solutions process for plastic pipe and resins which includes audits by the AASHTO Re:Source. Plants shall be listed as "Compliant" on the AASHTO Product Evaluation & Audit Solutions website and take immediate corrective action for any deficiencies found during audits. Continued compliance with all elements of the AASHTO Product Evaluation & Audit Solutions/ AASHTO Re:Source program and the Maine DOT manufactured Materials Verification Program will be required in order to continue supplying product to the Maine DOT.

## SECTION 707 - METALLIC PIPE

- 707.01 **Removed**
- 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 M 36/M

36M Type I, IR, II, or III for the specified sectional dimensions, sheet thickness, and coating.

707.03 **Removed**

707.04 **Removed**

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 M 36/M 36M, 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 M 196/M 196M, 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 M 196/M 196M. Aluminum sheet shall conform to the requirements of AASHTO M 197/M 197M.

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 M 245/M 245M, Type 1 with Grade 250/250 polymer coating. Steel sheet shall conform to the requirements of AASHTO M 246/M 246M.

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 M 196/M 196M, Type III, Class 1 perforations or Type IIIIR, Class 4 perforations.

707.09 **Steel Structural Plate Pipe, Pipe Arches, Arches, Box Culverts, and Fasteners** - Plates, bolts, nuts and other accessories shall conform to the requirements of AASHTO M 167/M 167M 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 Fabrication Engineer on an annual basis.
- c. The Fabrication 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 M 36/M 36M using steel sheet conforming to AASHTO M 274.

- 707.11 **Zinc - Coated (Galvanized) Corrugated Steel Pipe** - This pipe shall conform to the requirements of AASHTO M 36/M 36M using steel sheet conforming to AASHTO M 218.
- 707.12 **Removed**
- 707.13 **Removed**
- 707.14 **Aluminum Alloy Structural Plate Pipe, Pipe Arches, Arches, Box Culverts, and Fasteners** - Plates for this pipe shall conform to the requirements of AASHTO M 219/M 219M. 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.
- 708.02 **Removed**
- 708.03 **Pavement Marking Paint** - Paint for final and temporary pavement marking shall meet the requirements of the Maine DOT Maintenance Fast-Dry Water-Based Traffic Paint on file at Highway Maintenance in Augusta.
- Glass beads shall conform to the requirements of AASHTO M 247, 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 M 133 and AWPA Standard U1. All preservatives shall meet the requirements of the US EPA regulations under the Federal Insecticide, Fungicide and Rodenticide Act.

## SECTION 709 - REINFORCING STEEL AND WELDED STEEL WIRE FABRIC

- 709.01 **Reinforcing Steel** - Reinforcing steel, whether plain, galvanized, epoxy coated, or zinc and epoxy dual-coated, shall be deformed bars conforming to the requirements of AASHTO M 31 (ASTM A615). Bars shall be Grade 60 unless otherwise specified on the Plans. Epoxy coated reinforcing steel shall also conform to the requirements of AASHTO M 284 (ASTM A775). The requirements of AASHTO M 284 (ASTM A775), Sections 5.2.1, 5.3, 5.4, and 15.1 shall be mandatory. Zinc and epoxy dual-coated reinforcing steel shall conform to the requirements of ASTM A1055.

Low-carbon, chromium, reinforcing steel shall be deformed bars conforming to the requirements of ASTM A1035. Bars shall be Grade 100 and alloy Type CS unless otherwise specified on the Plans.

Stainless Steel Reinforcement shall be deformed stainless steel bars conforming to the requirements of ASTM A955. Bars shall be at a minimum Grade 60, unless otherwise specified on the Plans. The chemical composition shall conform to one of the types listed in Table 2 of ASTM A955 or UNS S32304 Duplex. Heat treatment condition per ASTM A955 is hot rolled. Bars shall be finished in accordance with ASTM A955, Section 15.

Fabricated deformed steel reinforcing grids shall conform to the requirements of AASHTO M 54 (ASTM A184). Welding and welder qualifications for reinforcing bar grids shall conform to the requirements in Section 503.

709.02 **Welded Steel** - Wire Fabric Welded steel wire fabric shall meet the requirements of AASHTO M 336 Standard Specification for Steel Wire and Welded Wire, Plain, and Deformed, for Concrete Reinforcement.

709.03 **Steel Strand** - Prestressing strand shall meet the requirements of AASHTO M 203 Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement.

Lateral post-tensioned strands for pre-cast/post-tensioned concrete products shall be 0.600" diameter AASHTO M 203 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 AASHTO M 280. The Design number shall be 12-4-5-14R with, coating Type Z, metallic coating Class 3 if zinc coated or coating Type A, (0.30 oz/ft<sup>2</sup>) if aluminum coated.

710.02 **Woven Wire** - Wire and stays shall conform to the requirements of AASHTO M 279. The Design number shall be 1047-12-11, Grade 60, coating Type Z, coating Class 3 if zinc coated. The Design number shall be 1047-12-11, Grade 60, coating Type A, if aluminum coated.

710.03 **Chain Link Fabric** - Chain Link fabric shall conform to the requirements of AASHTO M 181, Type I, Class D if zinc coated, or Type II if aluminum coated, or Type IV, Class B if PVC coated. The wire shall be 9 gauge and the mesh shall be 2" unless otherwise noted on the plans. Tension wire shall be 7 gauge (0.177" diameter) steel coil spring wire and have a zinc coating or an aluminum coating. Zinc coating shall be Class 3 and aluminum coating shall be a minimum of 0.4 oz/ft<sup>2</sup>.

710.04 **Metal Beam Rail** - Galvanized steel rail elements shall conform to the requirements of AASHTO M 180, Class A, Type II.

When corrosion resistant steel is specified, rail shall conform to AASHTO M 180, Class A, Type IV. Beams of corrosion resistant steel shall not be painted or galvanized. They shall be so handled and stored that the traffic face of these beams, used in a continuous run of guardrail, shall not show a distinctive color differential.

When metal beam rail is to be installed on a curve having a radius of curvature of 150 ft or less, the beam sections shall be fabricated on an arc to the required radius and permanently stamped or embossed with the designated radius.

The Department may take one piece of guardrail, a backup plate, and end or buffer section from each 200 pieces in a lot, or from each lot if less than 200 pieces are included therein for determination of compliance with specification requirements. If one piece fails to conform to the requirements of this specification, two other pieces shall be tested. If either of these pieces fails to conform to the requirements of this specification, the lot of material represented by these samples shall be rejected. A lot shall be considered that quantity of material offered for inspection at one time that bears the same heat and coating identification.

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 or other AWPA approved species, 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 1½" of taper in 7 ft.

The minimum diameter of heartwood in line posts at their small end shall be no less than 3". The minimum diameter of line posts at the small end shall be no less than 3". The maximum diameter of line posts at the small end shall be 6".

The minimum diameter of heartwood in end, corner, gate, and barway posts shall be 4½" at the small end. The minimum diameter of end, corner, gate, and barway posts at the small end shall be 4½". The maximum diameter of end, corner, gate, and barway posts shall be 8".

Braces shall be of spruce, eastern hemlock, Norway pine, pitch pine, or tamarack timbers or other AWPA approved species, or spruce, cedar, tamarack or other AWPA approved species round posts of sufficient length to make a diagonal brace between adjacent posts. All wood posts and braces shall be

pressure-treated in accordance with AASHTO M 133 and AWPA U1, UC4A Commodity Specification B: Posts.

Metal posts and braces for woven wire fence shall conform to the requirements of AASHTO M 281. Posts and post assemblies shall be galvanized according to the requirements of AASHTO M 111. Assembly hardware shall be zinc coated in accordance with AASHTO M 232M/M 232. The type of post furnished shall be channel or U unless otherwise noted on the plans.

Metal posts, rails, and bracing for chain link fence shall be as specified in AASHTO M 181. Type I, Grade 1 or Grade 2 posts shall be used with zinc coated chain link fabric. Type II, Grade 1 or 2 shall be used with aluminum coated chain link fabric. End and corner posts shall be 2" inside diameter. Line posts shall be 1½" inside diameter. Top and brace rails shall be 1¼" inside diameter. Expansion sleeves, turnbuckles and other fittings and hardware shall be galvanized in accordance with the applicable requirements in AASHTO M 181.

710.07 **Guardrail Posts** - Posts shall be of wood or steel.

- a. Wood posts shall be of Norway pine, southern yellow pine, pitch pine, Douglas fir, red pine, white pine, or eastern hemlock or other AWPA approved species. They shall be of 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 1" in diameter. The posts shall be free from season checks that exceed ¼" in width. A tolerance of 1" in length and ¼" 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 1½" wide and extending not more than ½ 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 2½" or less in diameter will be permitted.

Wood posts and offset brackets shall be preservative treated in accordance with the requirements of AASHTO M 133 and AWPA U1, UC4A Commodity Specification B: Posts.

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 M 270 Grade 250 (36) if a rolled section or ASTM A769 Grade 36 if a welded section. Fabrication will be in accordance with Section 504 - Structural Steel. Galvanizing shall be in accordance with Section 506 - Shop Applied Protective Coating - Steel.
- c. Corrosion resistant steel posts shall conform to the requirements of ASTM A769, Grade 50W if a welded section. Fabrication will be in accordance with Section 504 - Structural Steel. The portion of the post that is

underground shall meet the galvanized steel post requirements in Section b. above.

- 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, and other accessories shall be in accordance with the requirements of AASHTO M 111, M 232 or AASHTO B 695, Class 50, Type I, whichever applies. All galvanizing shall be done after fabrication.

Hardware for corrosion resistant guardrail shall be in accordance with ASTM A25M/A325, Type 3, except the 16" 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, Splices and Tips** - Steel pipe piles shall conform to the requirements of ASTM A252. The steel pipe piles shall be Grade 3,  $F_y = 45$  ksi, 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 Welding Code - Steel.

Cast steel points, splices and open end cutting shoes shall conform to the requirements of ASTM A27 Grade 65/35 or ASTM A148 Grade 90/60. Pipe pile splice backup ring material shall be any steel listed in AWS Structural Steel Welding Code D1.1, Table 3.1, with the exception of 100 ksi minimum yield strength steels

- 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 3" by 4" 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 0.1181" after galvanizing. The diameter of the selvedge wire, running through all the edges (perimeter wire), shall be 0.1535" after galvanizing. The diameter of the wire for assembling and

lacing the gabion units shall be 0.0866" 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 0.015" 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 A975. The diameter of the steel wire mesh shall be 0.1063" after galvanization and 0.1363" overall, core wire plus PVC coating.

The diameter of the selvedge wire running through all the edges (perimeter wire) shall be 0.1338" after galvanizing and 0.1638" overall, core wire plus PVC coating. The diameter of the wire for assembling and lacing the gabion units shall be 0.0866" after galvanizing and 0.1166" 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 6 ft long and of a minimum width of 3 ft, including all selvedge bindings, shall have the ends securely clamped for 3 ft along the width of the sample. When the width of the section under test exceeds 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 1 ft<sup>2</sup> 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 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 4" in all directions and a maximum dimension of 12".

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

- 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 506 - Shop Applied Protective Coating-Steel.
- 711.05 **Removed**
- 711.06 **Stud Shear Connectors, Anchors and Fasteners** - Shear connectors shall meet the dimensional tolerances of Figure 9.1 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 9 of the D1.5 Code. Shear connectors shall meet the mechanical property requirements of Table 9.1, Type B of the D1.5 Code. Anchors and fasteners shall meet the mechanical property requirements of Table 9.1 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 2½ by 3¼" 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 0.0866" after galvanizing. The diameter of the selvedge wire, running through all the edges (perimeter wire), shall be 0.1063" after galvanizing. The diameter of the wire for assembling and lacing the units shall be 0.0866" 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 0.015" 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 A975 The diameter of the steel wire mesh shall be 0.0866" after galvanization and 0.1166" overall minimum, core wire plus PVC Coating.

The diameter of the selvedge wire running through all the edges (perimeter wire) shall be 0.1050" after galvanizing and an overall minimum diameter of 0.1350", core wire plus PVC coating. The diameter of the wire for assembling and lacing the units shall be 0.0866" after galvanizing and

0.1166" nominal overall, core wire plus PVC coating. All wire sizes shall have a tolerance of  $\pm 2.5\%$ , the thickness of the PVC excluded.

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

- An uncut section of mesh 6 ft long and a minimum width of 3 ft, including all selvedge bindings, shall have the ends securely clamped for 3 ft along the width of the sample.
- When the width of the section under test exceeds 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 1 ft<sup>2</sup> 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 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 3" in all directions and a maximum dimension of 6".

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 Sections 18.10.2 of AASHTO LRFD Bridge Construction Specifications, where applicable.

711.10 ***H-Beam Piles, Splices and Tips*** - Steel H-beam piles shall be ASTM A572, Grade 50 minimum.

Steel H-beam pile splicers shall be ASTM A572, Grade 50 minimum.

H-Beam pile tips shall consist of pile points equipped with cutting teeth. The slope forming the point shall not be steeper than 1¾:1. Material for H-Beam pile tips shall consist of plain cast steel pile points conforming to the requirements of AASHTO M 103 (ASTM A27), Grade 65/35 or ASTM A148, Grade 80/50. 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 conform to AASHTO LRFD Bridge Construction Specification Section 18.2.3 except that the elastomer compound shall be Grade 3 or 4 or 5, unless otherwise noted on the Plans. A higher grade of elastomer may be substituted for a lower one.
- 711.12 **Stainless Steel** - Stainless steel shall conform to the requirements of ASTM A167 Type 308 or ASTM A240, Type 304.
- 711.13 **Polytetrafluoroethylene (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

- 712.01 **Removed**
- 712.02 **Calcium Chloride** - Calcium chloride shall conform to the requirements of AASHTO M 144.
- 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. 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  $\frac{3}{4}$ " 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  $\frac{1}{8}$ ". The top front arris line shall be pitched straight and true with no variations from a straight line greater than  $\frac{1}{4}$ ". The top back arris line shall meet the same requirement except that indentations of a maximum of  $\frac{3}{8}$ " 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 3".

The front face shall be at right angles to the top and shall be smooth split and have no Projections greater than 1" or depressions greater than  $\frac{1}{2}$ ", measured from the vertical plane of the face through the top arris line for a distance down from the top of 8". The remainder of the face shall have no Projections or depressions greater than 1" 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 ¼" no more than ⅝" 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 8" from the plane of the joint.

Drill holes through the curb will be allowed providing they are at least 9" 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

Natural grain size and color variations characteristic of the source deposit will be permitted.

- 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 4 ft nor greater than 10 ft. Random lengths of curb less than 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 60 ft or less shall be cut.

- 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 1", 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 1" 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 18" from each end of the stone and spaced horizontally at a maximum of 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  $\frac{1}{2}'' \pm \frac{1}{8}''$ . 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 1" to show between a 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 3" in length and  $\frac{3}{4}''$  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  $\frac{1}{8}''$ . The arris lines at the bottom of the face shall be straight and true so that not over 1" 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  $1\frac{1}{2}''$  will show in the joint for the width of the face.

When Type 5 Curbing 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 preformed into rolls or ribbons of various lengths, pliability, and widths suitable for use as reflecting pavement markings on Portland Cement concrete or hot mix asphalt pavement. The pavement marking material used shall be from the Department's QPL and have been tested through AASHTO Product Evaluation & Audit Solutions.

**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 retro-reflectance 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.

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

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

The test distance shall be 50 ft and the sample size a 2 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 2 by 6" sample bent over a ½" diameter mandrel with the 2" 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 60°F and rising.

Special instructions should be supplied by the vendor for application to be made at pavement temperatures below 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 2" from construction joints of Portland Cement concrete pavement. When directed by the Resident, opening of 6" lengths shall be left at 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 AASHTO M 199 except as modified below.

Approved structural fibers may be used as a replacement of 6 x 6 #10 gauge welded wire fabric when used at an approved dosage rate for the construction of manhole and catch basin units. The material used shall be one of the products listed on the Maine Department of Transportation's Qualified Products List of Macro Synthetic Fibers for Concrete Reinforcement.

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 6.0% air content, plus or minus 1.5% tolerance when tested according to AASHTO T 152. All concrete shall develop a minimum compressive strength of 4000 psi in 28 Days when tested according to AASHTO T 22. The absorption of a specimen, when tested according to AASHTO T 280, Test Method "A", shall not exceed 9.0% of the dry mass.

712.061 **Structural Precast Concrete Units** - Shall be made per Standard Specification Section 534

712.07 **Catch Basin and Manhole Frames, Grates and Covers, Drainage, Sewer, Utility, and related castings** - shall conform to the plan dimensions and shall be gray iron or ductile iron castings conforming to the requirements of AASHTO M 306.

712.08 **Corrugated Metal Units** - The units shall conform to plan dimensions and the metal to AASHTO M 36/M 36M. Bituminous coating, when specified, shall conform to AASHTO M 190 Type A.

712.09 **Catch Basin and Manhole Steps** - Steps for catch basins and for manholes shall conform to ASTM C478M [ASTM C478], Section 13 for either of the following material:

(a) **Aluminum steps** - ASTM B221M, [ASTM B211] Alloy 6061-T6 or 6005-T5.

(b) **Reinforced plastic steps** - Steel reinforcing bar with injection molded plastic coating copolymer polypropylene. Polypropylene shall conform to ASTM D4101.

712.10 – 712.22 **Removed**

712.23 **Flashing Lights** - Flashing Lights shall be power operated or battery operated as specified.

(a) Power operated flashing lights shall consist of housing, adapters, lamps, sockets, reflectors, lens, hoods and other necessary equipment designed to give clearly visible signal indications within an angle of at least 45° and from 10 to 300 ft under all light and atmospheric conditions.

Two circuit flasher controllers with a two-circuit filter capable of providing alternate flashing operations at the rate of not less than 50 nor more than 60 flashes per minute shall be provided.

The lamps shall be 650 lumens, 120 volt traffic signal lamps with sockets constructed to properly focus and hold the lamp firmly in position.

The housing shall have a rotatable sun visor not less than 7" in length designed to shield the lens.

Reflectors shall be of such design that light from a properly focused lamp will reflect the light rays parallel. Reflectors shall have a maximum diameter at the point of contact with the lens of approximately 8".

The lens shall consist of a round one-piece convex amber material which, when mounted, shall have a visible diameter of approximately 8". They shall distribute light and not diffuse it. The distribution of the light shall be asymmetrical in a downward direction. The light distribution of the lens shall not be uniform, but shall consist of a small high intensity portion with narrow distribution for long distance throw and a larger low intensity portion with wide distribution for short distance throw. Lenses shall be marked to indicate the top and bottom of the lens.

- (b) Battery operated flashing lights shall be self-illuminated by an electric lamp behind the lens. These lights shall also be externally illuminated by reflex-reflective elements built into the lens to enable it to be seen by reflex-reflection of the light from the headlights of oncoming traffic. The batteries must be entirely enclosed in a case. A locking device must secure the case. The light shall have a flash rate of not less than 50 nor more than 60 flashes per minute from minus 20°F to plus 150°F. The light shall have an on time of not less than 10% of the flash cycle. The light beam projected upon a surface perpendicular to the axis of the light beam shall produce a lighted rectangular projection whose minimum horizontal dimension shall be 5° each side of the horizontal axis. The effective intensity shall not have an initial value greater than 15.0 candelas or drop below 4.0 candelas during the first 336 hours of continuous flashing. The illuminated lens shall appear to be uniformly bright over its entire illuminated surface when viewed from any point within an angle of 9° each side of the vertical axis and 5° each side of the horizontal axis. The lens shall not be less than 7" in diameter including a reflex-reflector ring of ½" minimum width around the periphery. The lens shall be yellow in color and have a minimum relative luminous transmittance of 0.440 with a luminance of 2854 Kelvin. The lens shall be one-piece construction. The lens material shall be plastic and meet the luminous transmission requirements of this specification. The case containing the batteries and circuitry shall be constructed of a material capable of withstanding abuse equal to or greater than 1.21 mm thick steel [No. 18 U.S. Standard Gauge Steel]. The housing and the lens frame, if of metal shall be properly cleaned, degreased and pretreated to promote adhesion. It shall be given one or more coats of enamel which, when dry shall completely obscure the metal. The enamel coating shall be of such quality that when the coated case is struck a light blow with a sharp tool, the paint will not chip or crack and if scratched with a knife will not powder. The case shall be so constructed and closed as to exclude moisture that would affect the proper operation of light. The case shall have a weep hole to allow the escape of moisture from condensation. Photoelectric controls, if provided, shall keep the light operating whenever the ambient light falls below 215 lx [20 foot-candles]. Each light shall be plainly marked as to the manufacturer's name and model number.

If required by the Resident, certification as to conformance to these specifications shall be furnished based on results of tests made by an independent testing laboratory. All lights are subject to random inspection and testing. All necessary random samples shall be provided to the Resident upon request without cost to the Department. All such samples shall be returned to the Contractor upon completion of the tests.

712.24 – 712.31 **Removed**

712.32 **Copper Tubing** - Copper tubing and fittings shall conform to the requirements of ASTM B88M Type A [ASTM B88, Type K] or better.

712.33 **Non-metallic Pipe, Flexible** - Non-metallic pipe and pipe fittings shall be acceptable flexible pipe manufactured from virgin polyethylene polymer suitable for transmitting liquids intended for human or animal consumption.

712.34 **Non-metallic Pipe, Rigid** - Non-metallic pipe shall be Schedule 40 polyvinylchloride (PVC) that meets the requirement of ASTM D1785. Fittings shall be of the same material.

712.341 **Metallic Pipe** - Metallic pipe shall be ANSI, Standard B36.10, Schedule 40 steel pipe conforming to the requirements of ASTM A53 Types E or S, Grade B. End plates shall be steel conforming to ASTM A36/A36M.

Both the sleeve and end plates shall be hot dip galvanized. Pipe sleeve splices shall be welded splices with full penetration weld before galvanizing.

712.35 **Epoxy Resin** - Epoxy resin for grouting or sealing shall consist of a mineral filled thixotropic, flexible epoxy resin having a pot life of approximately one hour at 50°F. The grout shall be an approved product suitable for cementing steel dowels into the preformed holes of curb inlets and adjacent curbing. The sealant shall be an approved product, light gray in color and suitable for coating the surface.

712.36 **Hot Mix Asphalt Curb** - The performance graded asphalt binder for hot mix asphalt curb shall meet a PG 58-28 or a PG 64-28. The aggregate shall conform to the requirements of Subsection 703.07. The coarse aggregate portion retained on the No. 8 sieve may be either crushed rock or crushed gravel.

The mineral constituents of the hot mix asphalt shall be sized and graded and combined in a composite blend that will produce a stable durable curbing with an acceptable texture.

Hot Mix Asphalt for curb shall meet the requirements of Section 403 - Hot Mix Asphalt Pavement.

712.37 **Precast Concrete Slab** - Portland Cement concrete for precast slabs shall meet the requirements of Section 502 - Structural Concrete, Class A.

The slabs shall be precast to the dimension shown on the plans and cross section and in accordance with the Standard Detail plans for Concrete Sidewalk

Slab. The surface shall be finished with a float finish in accordance with Subsection 502.14(c). Lift devices of sufficient strength to hold the slab while suspended from cables shall be cast into the top or back of the slab.

- 712.38 **Stone Slab** - Stone slabs shall be of granite from an acceptable source, hard, durable, predominantly gray in color, free from seams which impair the structural integrity and be of smooth splitting character. Natural color variations characteristic of the deposit will be permitted. Exposed surfaces shall be free from drill holes or indications of drill holes. The granite slabs in any one section of backslope must be all the same finish.

The granite slabs shall be scabble dressed or sawed to an approximately true plane having no Projections or depressions over ½" under a 2 ft straightedge or over 1" under a 4 ft straightedge. The arris at the intersection of the top surface and exposed front face shall be pitched so that the arris line is uniform throughout the length of the installed slabs. The sides shall be square to the exposed face unless the slabs are to be set on a radius or other special condition which requires that the joints be cut to fit, but in any case shall be so finished that when the stones are placed side by side no space more than ¾" shall show in the joint for the full exposed height.

Lift pin holes in all sides will be allowed except on the exposed face.

## **SECTION 713 - STRUCTURAL STEEL AND RELATED MATERIAL**

- 713.01 **Structural Steel** - Highway bridge steel shall meet the requirements of AASHTO M 270. 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, Table 11, Zone 2, for non-fracture critical steel or Table 12, Zone 2 for fracture critical steel. Frequency of tension tests shall comply with the requirements of S1.

IMPACT TEST SAMPLING AND TESTING PROCEDURES SHALL BE IN ACCORDANCE WITH AASHTO T 243 M/T 243 AND AASHTO T 244.

Steel for ancillary bridge products and steel structures shall conform to AASHTO M 270 or one or more of the following:

- ASTM A36
- ASTM A572
- ASTM A588
- ASTM A53
- ASTM A500
- ASTM A595 Grade C
- ASTM A786
- ASTM A847
- ASTM A992

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 ASTM F3125, Grade A325, Type 1 or Type 3. Type 3 bolts shall be supplied for all structures utilizing unpainted AASHTO M 270M weathering steel. Type 1 galvanized bolts shall be used for all structures utilizing metallized or galvanized steel.

Nuts shall meet the requirements of ASTM A563.

Circular and beveled washers shall conform to the requirements of ASTM F436.

Direct Tension Indicators (DTI'S) shall conform to the requirements of ASTM F959. 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 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 ASTM B695 Class 50, Type I.

"Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies shall meet the requirements of ASTM F3125, Grade F1852.

Bolts, nuts and washers specified to be galvanized, shall be galvanized in accordance with AASHTO M 232 (ASTM A153), ASTM F2329, or 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.

**TABLE 1 - TEST SCHEDULE\***

Bolts	Tensile Strength (Wedge Test) Proof Load Hardness Coating Thickness	ASTM F606 ASTM F606 ASTM F606 ASTM B695
Nuts	Proof Load Hardness Coating Thickness	ASTM F606 ASTM F606 ASTM B695
Washers	Hardness Coating Thickness	ASTM F606 ASTM B695
DTI's	Coating Thickness Compression Load	ASTM B695 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 1/8" 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 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 M 107 (ASTM B22), Alloy No. 911 and copper alloy bearing and expansion plates shall conform to the requirements of AASHTO M 108, (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 M 169. 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, for use other than for drainage castings, (Section 712.07) shall conform to the requirements of AASHTO M 105. Class Number 35 shall be furnished unless otherwise specified.

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

Carbon Steel Castings for General Applications shall conform to the requirements of AASHTO M 103. The grade 70-36 of steel 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 M 36.

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 77°F, 3.5 oz, 5 seconds	0.14 - 0.018"
Loss on heating at 325°F, 1.75 oz, 5 hours	Not more than 1.5%
Flash point (open cup)	Not less than 440°F
Penetration at 77°F, 3.5 oz, 5 seconds, of residue after heating at 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 M 20.

Whenever possible in the manufacture of the units, a minimum forming radius of 1" is to be maintained. All units that are formed with less than 1" 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 AASHTO M 232.

- 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 M 297.

- 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	5°F to 120°F minimum
Film Strength (ASTM D412)	1,200 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 5 ft or less. Actual seal

dimensions shall not differ from the nominal dimensions by more than 1/16"/inch of depth or width, or a maximum of 1/4" whichever is less.

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

## SECTION 715 - LIGHTING MATERIAL

- 715.01 **Removed**

- 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 AASHTO M 232.

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** - Prewired conduit will no longer be accepted

- 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, THWN or XHHW.

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 13/32" in diameter and 1½" 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.

715.08 **Luminaire LED fixtures** -The luminaire shall be designed for the wattage rating and voltage indicated on the plans and for operating on a multiple circuit. All luminaries shall be new and be the product of the same manufacture

The LED shall have a minimum of 100,000 hours and have a 10 year warranty on the fixture and led modules.

Light color temperature shall be 5000-5500 k. Each fixture shall have a minimum of at least 2 separate light sources. Lenses or refractors shall be guaranteed not to yellow for a period of 20 years. Fixtures shall be IES full cutoff. Lm 80 test data shall be supplied in the bid package

The LED fixtures must be equipped with a Smart Driver. The Smart Driver shall provide current regulation for individual light clusters. Current accuracy over the LED operating temperature range must be +/- 3%. It shall have over temperature

protection, shut down at critical temperature and resume operation temperature. Under voltage lockout for power off or brownout.

The line side of each fixture/ retrofit must have surge suppression that meets or exceeds ANSI/IEEE C62.41-2002 Category C-.

Led fixtures shall have a lamp lumen depreciation of no more than (LLD) 15% over 52,000 hours, 12 years.

On any Contract supplying at least 10 light fixtures 1 additional spare fixture for each 10 fixtures shall be supplied to Maine Department of Transportation.

715.09 **Luminaire, Lamp and Ballast for High Mast Lighting** - Shall conform to 715.08. 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 2.0 foot-candles and off at approximately 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. All service equipment new or upgraded shall be marked with an appropriate arc flash plaque or decal with the following information :

- Flash hazard boundary
- Cal/cm<sup>2</sup> hazard at 18"
- PPE level
- Shock hazard when cover is
- Limited approach boundary
- Restricted approach boundary
- The prohibited approach boundary

This shall be located on the outside of the equipment and shall be visible, weatherproof, and fade resistant, and not easily removed.

All new controller cabinets, traffic signal or lighting, shall be configured to eliminate arc flash. All electrical equipment will be dead front, no open terminals, bus bars, breakers, or exposed terminal strips.

All live parts over 50 volts shall be covered with Lexan or a suitable barrier to eliminate the possibility of an arc flash.

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. **Contactors** - One double pole, single throw solenoid (shall be non-mercury) 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, 5/8" diameter, 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 239°F rise at 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 6" 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 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. 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 hand hole 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 B221, Alloy 6061-T6 or 6351-T5. Post and post bases shall conform to the requirements of ASTM B221, Alloy 6061-T6. Pales shall conform to the requirements of ASTM B429 Alloy 6063-T5. Washers shall conform to the requirements of ASTM B209, Alloy Alclad 2024-T4.
- b. **Aluminum Rivets** - Rivets shall conform to the requirements of ASTM 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 B211, Alloy 5056 (Stabilized), 2) Pin - ASTM 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 or ASTM B108, Alloy A356-T6. All aluminum bars and plates shall conform to the requirements of ASTM 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. Nuts embedded in concrete shall conform to the requirements of ASTM A307.  
  
Anchor bolts, exposed nuts and washers shall conform to the requirements of ASTM A449 or ASTM F1554, Grade 55 and shall be galvanized in accordance with AASHTO M 232 (ASTM A153), ASTM F2329, or ASTM B695, Class 50, Type I.
- 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

Property	Specification	Breakdown of Property
Nitrogen (N)	23%	At least 50% from slow release sources
Phosphorus (P)	0%	No phosphorus
Potassium (K)	12%	40% from potassium magnesium sulphate
Iron (Fe)	1%	From iron sulphate

- b. **Slow Release Fertilizer Tablets** - Planting Tablets shall be a long lasting 20-10-5 plus minors ¾ oz tablet.
- c. **Water Soluble Fertilizer** - shall be:

Property	Specification
Nitrogen	20%
Phosphorus	10%
Potassium	20%

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

717.011 **Humic Acid Soil Conditioner** - Humic Acid Soil Conditioner shall come from naturally occurring dry granular unaltered oxidized lignite, also called Humate, or equivalent product approved by the department's landscape architect, crushed to a particle size which passes a US standard 7 mesh screen [ $\frac{1}{8}$ "]. Humate or equivalent product shall have a Humic Acid equivalent content of 70% (by weight).

717.02 **Agricultural Ground Limestone** - Agricultural ground limestone shall have the following mechanical analysis:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
No. 10	100
No. 20	90-100
No. 100	50-100
Total Carbonates	$\geq 80$

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 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 water soluble and contain the following analysis:

Property	Specification
Elemental Calcium (Ca)	19%
Nitrogen (N)	15.5 % of which 1% is from Ammoniacal Nitrogen and 14.5 % is from Nitrate Nitrogen

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:

Property	Specification
Germination	>80%
Pure Live Seed	>85%
Purity	>85%
Weed Seed	<1.0%

All seed shall be from the current year's 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:

Method #1 - Park Mixture	
Property	Specification
Creeping Red Fescue	45% +/- 4%
Kentucky Bluegrass	25 +/- 4%
Chewings Fescue	15 +/- 4%
Perennial Ryegrass	10 +/- 2%
Annual Ryegrass	5 +/- 2%
Method #2 - Roadside Mixture #2	
Property	Specification
Red Fescue	35% +/- 4%
Sheep Fescue	35% +/- 4%
Red Top	5% +/- 2%
White Clover	6% +/- 2%
Annual Rye	19% +/- 2%
Method #3 - Roadside Mixture #3	
Property	Specification
Crown Vetch	50% +/- 4%
Perennial Lupine	25 % +/- 4%
White Clover	4% +/- 4%
Perennial Rye Grass	21% +/- 4%

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.
- (b) **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.

- (c) **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.
- (d) **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:

Property	Specification
pH	4.0 to 8.0
2" Sieve Designation	100% passing
Soluble Salts Content	<4.0 mmhos/cm

- (e) **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 4" in diameter and shall be a well graded material conforming to the following:

Property	Specification
pH	5.0 to 8.0
6" Sieve Designation	100% passing
¾" Sieve Designation	75 to 85% passing
Soluble Salts Content	<4.0 mmhos/cm
Organic Matter	20 to 100%, dry weight basis

- (f) **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:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
¾"	100
¼"	0-10

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 5 lb/unit. 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 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 1.55 lb/ft<sup>2</sup>. The blanket shall remain intact until grass is established. The blanket shall be a product currently listed on the department's Qualified Products List (QPL) of Rolled Erosion Control Products.

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 **Humus** - Humus shall be an organic substance meeting the following:

Property	Specification
pH	4.5 to 8.0
1" Sieve Designation	100% passing
Soluble Salts Content	<4.0 mmhos/cm
Organic Matter	35%, minimum
Dewar Self Heating	>5 stability

Humus may be a natural peat from sedge, sphagnum or reed origin, or compost from source separated materials that may include leaf and yard trimmings, food scrapes, food processing residues, manure and other agricultural residuals, or biosolids. 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. All new traffic signal (vehicular and/or pedestrian) heads shall have light emitting optical assemblies for all colors.

There shall be a round opening in the top and bottom of each head to receive 1½" supporting pipe frame. All parts of the housing, including the

doors and end plates shall be of die cast aluminum or polycarbonate free from flaws, cracks, blow holes, or other imperfections.

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 8" sections shall be 7" long, hoods for 12" sections shall be 9½" 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 8" units shall be 650 lumen minimum initial output, 120 volt, 100,000 hour rated life, clear traffic signal lamps. Lamps for the 12" 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 thermetically 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 or polycarbonate, 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 1½" 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.

- c. All exposed wiring for traffic signals, beacons, solar panels, etc. shall be IMSA 19-1 rated and be of sufficient size to carry the full load unless approved by the resident engineer

718.02 **Pedestrian Signal Indications** - All pedestrian signal head indications shall be displayed within a rectangular background and shall consist of symbolized messages (Upraised Hand and Walking Person).that shall be at least 6" high. All pedestrian heads shall be LED optical assemblies and shall have countdown displays.

LED optical assemblies 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 5" minimum in height with a 5/8" 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 1½" IPS pipe to permit the signal control wires or cable to be inserted through them. For polycarbonate signal heads with 3 or more sections or requiring mounting extensions greater than 12" in length, reinforcing plates shall be used to reinforce the housings at the point of attachment. The bottommost section of a signal head assembly mounted on a pedestal pole shall have an aluminum housing.

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 70

mph and at any temperature between -35 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, fuse holders, 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 750 ft for single detection loops and for a combined lead-in length of 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 detectors shall conform to MUTCD requirements.

718.07 **Controllers**

All traffic signal controllers (controllers) shall be rack-mounted, solid state, menu driven, keyboard units conforming to the ATC 5201 v06.25 Advanced Transportation Controller (ATC) Standard. The controller shall be supplied with all necessary interfaces needed to support Advanced Transportation Controller Cabinet (ATCC) / Serial Interface Unit (SIU) communications. The controller shall be designed and supplied to provide the number of phases and sequencing as shown on the plans without any auxiliary equipment. Each controller supplied shall be the same manufacturer, model and contain the same firmware level and version number; the type of controller, auxiliary equipment, and other operational features shall be as noted on the plans.

Traffic signal controllers shall meet the following requirements:

- Contain ATC API operational software conforming to ATC 5401 Standard v02.
- Be configured to operate in an ATCC 5301 v02 cabinet platform.
- Be supplied with the appropriate version of the Linux operating system, Board Support Package (BSP) and internal processing levels necessary to support connected vehicle (CV) as well as local and system operations.
- Be fully compliant with NTCIP 1201 and 1202 standards.
- Include a minimum of 3 High Speed USB 2.0 ports.
- Include a minimum of 3 10/100BaseT, RJ45 Ethernet connector ports.
- Meet the functional requirements of the NEMA TS-2, 2016 Standard, including all amendments.
- Support Flashing Yellow Arrow (FYA) and Flashing Red Arrow (FRA) operation with the ability to provide a minimum of 6 flashing pairs.
- Be supplied with an internal real-time clock and calendar capable of daily, weekly, and yearly event programming.
- 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.
- When on manual operation per input from the ATCC, 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. All phases shall be called regardless of vehicle or pedestrian detection.

- Pedestrian phases shall not be extended or reserviced by actuation of the pedestrian detector during the walk interval, pedestrian clearance interval, or current phase and actuations shall be placed into memory and serviced in a following phase or cycle.
- Have documented compatibility with the MaineDOT traffic signal central management system (TSCMS) to meet the applicable requirements in this specification. If a documented history cannot be provided, then it will be the contractor's responsibility to coordinate a demonstration of the proposed controller to show the available functionality when connected to the MaineDOT TSCMS before the submittal of the proposed controller will be approved.
- Contain the ability to alter the controller unit's internal database using a built-in front panel keyboard, using a computer connected to the controller unit with an Ethernet cable, and remotely using either a web-based user interface or the MaineDOT TSCMS.
- Be supplied and installed with the ability to collect, store, and report various measures of effectiveness (MOE's) including or equivalent to:
  - Event and Alarm history
  - Flash Status
  - Stop Time Status
  - Cabinet Door Status (Open and Closed)
  - Coordination Status (Active, Failure, and Faults)
  - Preemption Events
  - Unit Control (System, Time Base, Interconnect, and Manual)
  - System Activity
  - Record and log vehicle detector actuations depending on user customizable parameters such as bin size.
  - Vehicle speeds using either one-detector or two-detector configuration.
- Shall collect and process all 255 high resolution enumerations as defined in the report "Indiana Traffic Signal Hi Resolution Data Enumerations", dated November 2012. This data will be processed in the controller and be available to be transferred to the MaineDOT TSCMS or via download from the web-based user interface. If communications are not available, then the data can be transferred through a USB memory device connected to the front of the controller.
- Be able to backup and restore Controller programming data to a USB memory device connected to the front of the controller. No additional software shall be required to perform this function.

- Be able to backup and restore Controller programming data using either a web-based user interface or through the MaineDOT TSCMS.
- Be able to upgrade the Controller firmware via USB memory device connected to the front of the controller. No additional software shall be required to perform this function.

### ***Construction Requirements***

- 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.
- All equipment inputs, outputs, and terminals shall be identified by the phase designations shown on the plans.
- The field electrical loading for flash operation shall be wired through the transfer relays such that the load on the 2-circuit flasher is as balanced as possible within the limitations of the signal phasing.
- Electrical filtering/surge protection shall be supplied and installed in each cabinet in accordance with ATCC 5301 v02 requirements and the manufacturer's recommendations. At a minimum, surge suppression shall be provided for incoming electric utility power conductors, all signal control circuits, vehicle detection, and pedestrian detection terminations.
- 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 percent of the total connected load and shall meet standards of the UL and the EIA.
- If noted on the plans, hardwire 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.

- The reliability of the equipment shall be demonstrated by test performance detailed in 718.08 that will confirm that the controller unit, fully wired cabinet, and auxiliary equipment meet the operational and functional requirements of the plans and specifications.

718.08 **Controller Cabinet** - The traffic signal control equipment shall be enclosed within a dust and moisture-proof aluminum housing with an auxiliary door in door feature. There are two cabinet configuration options that are specified for use; a ground mounted cabinet and a pole mounted cabinet.

All new controller cabinets, traffic signal, or lighting, shall be configured to eliminate arc flash. All electrical equipment will be dead front, no open terminals, busbars, breakers, or exposed terminal strips. The cabinet shall be designed, constructed, and installed with all necessary provisions to comply with the latest NFPA 70E requirements. All electrically live parts over 50 volts shall be covered with Lexan or a suitable physical barrier to eliminate the possibility of an arc flash.

All wiring shall comply with all applicable local electrical codes as well as the National Electric Code.

#### **Cabinet Requirements**

The ground mounted cabinet shall be a NEMA "P" size cabinet (44"W x 26"D x 67"H). The cabinet front provides for user interface to the in-cabinet equipment including the front panel of the controller, the cabinet status displays and detection system control interface. The cabinet rear provides access for cable termination and shall only be accessed for installation and for cabinet troubleshooting. The cabinet shall be supplied with four doors; two on the front face and two on the back face. Each door shall open independently with an independent center post latching for each of the four doors. The cabinet shall be supplied with two side by side, 19" rack cages which shall extend from the bottom to the top of the cabinet. The left-side rack of the cabinet relative to facing the cabinet from the front, to be referred to as the 'Control' side, shall house the control devices such as the controller, Cabinet Monitor Unit (CMU) and Auxiliary Display Unit (ADU), switch packs and power distribution panel. The right-side rack of the cabinet relative to facing the cabinet from the front, to be referred to as the 'Power and Auxiliary' side, shall house the spare card cage assembly and battery back-up devices and communications elements. The ground mounted cabinet shall meet the following additional requirements:

- The spare card cage assembly shall not be wired to any cabinet device, but rather used to store spare rack mounted cabinet devices such as switch packs, serial interface units (SIUs), CMUs, and phase selectors.
- Be supplied with 32 output channels and 48 input channels.
- Be supplied with a 6" minimum high riser aluminum base that elevates the cabinet above the cabinet foundation.

- 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.
- Be supplied and installed with an electric service meter socket trim and electrical service disconnect switch mounted on the exterior, Power and Auxiliary side of the cabinet. The meter and disconnect switch shall be installed centered on the side of the cabinet without doors such that it is not less than 48" nor more than 60" above final grade. The Contractor shall coordinate with the local electric utility company to determine the appropriate type of electric service meter socket trim and electrical conductors to be used. The line side cable shall be routed external to the cabinet from the ground to a 50 amp disconnect switch, then continuing to the bottom of the electric service meter socket trim, all through rigid steel conduit furnished and installed by the Contractor. The load side cable shall be routed through the cabinet and terminated on the line side of the main cabinet circuit breaker. The cable shall be routed between the edge of the rack system and the cabinet side wall, along the bottom of the cabinet, and below the bottom opening of the doors so that the cable does not block or enter into available rack space. Care shall be taken by the Contractor when installing the electric service meter socket trim and electrical service disconnect switch so that there is no damage inflicted on installed devices or the rack system during the installation. All metal shavings produced during the drilling of the access hole for the electric service shall be removed from the cabinet interior by the Contractor. The Contractor shall install appropriate bushings to all cabinet penetrations.

The pole mounted cabinet shall be a Model 336S cabinet (24" W x 20" D x 46" H). The cabinet shall be supplied with a 19" rack cage which shall extend from the bottom to the top of the cabinet. The cabinet shall be supplied with two doors; one on the front face and one on the back face. The cabinet front provides for user interface to the in-cabinet devices including the front panel of the controller, the cabinet status displays and detection system control interface. The cabinet rear provides access for cable termination and shall only be accessed for installation and for cabinet troubleshooting. The pole mounted cabinet shall meet the following additional requirements:

- 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 the controller cabinet is to be ground mounted, details of the installation will be shown on the plans. Piano type hinges on cabinet doors shall be fabricated of stainless steel with a stainless-steel hinge pin. The cabinet shall be supplied with reinforcing plates where the cabinet is supported by the pole hangers.
- Be supplied with 16 output channels and 24 input channels.

- Require an electric service meter and disconnect switch system to be installed as indicated in the Plans or as directed by the Resident and approved by the local electric utility company. Line side cable shall be installed in a rigid steel conduit, flexible liquid tight conduit or PVC Schedule 80 conduit from the meter and disconnect to the underside of the pole mounted cabinet.

Both the ground mount and pole mount cabinets shall be configured to provide the following output/input channel assignments:

<b>Channel</b>	<b>Input</b>	<b>Output</b>
1-8	Vehicle Phase Call 1-8	Vehicle Phase 1-8
9-12	Pedestrian Phase Call 2,4,6,8	Pedestrian Phase 2,4,6,8
13-16		Overlap A, B, C, D
17+	Special Functions	

The cabinet shall be supplied with a police door panel located in the middle area of the front door for both cabinet types. The switches shall be mounted in the police panel and labelled as to function. Four switches shall be supplied as follows:

- Power On/Off
- Signal On/Off
- Signal/Flash
- Manual/Auto with cord

The manual control cord shall be a coiled type, sealed weather proof covered hand switch extending to six feet when fully stretched. The cord shall be fastened to the cabinet via a compression type connector to provide strain relief for the cord's electrical connections. The police door panel shall be of sufficient size so as to store the manual control cord when panel door is closed.

The cabinet shall be supplied with a technician's panel mounted on the back of the police panel. This panel shall be supplied with the following switches:

- Controller On/Off
- Flash/Auto (Allows the controller to cycle while flashing)
- Signals On/Off (Allows the controller to cycle with signal displays being dark)
- Stop Time Normal/On (Provides the ability to manually activate a controller stop time input)

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 cabinet shall be supplied with white LED light panels which shall automatically illuminate via a door open switch whenever one of the four main cabinet doors are opened for the ground mount cabinet or two main doors for the side of pole cabinet. The ground mounted cabinet shall contain four LED light panels per side totaling eight panels for the cabinet; one panel each at the top and bottom portion of the front side and back side on the Control side and Power/Auxiliary side of the cabinet. Each light panel shall produce a minimum of 250 lumens for a total minimum lumen output of 2000 lumens with all eight panels illuminated. The minimum output per side would be 1000 lumens. The LED panels shall be protected by a clear shatterproof shield. The side of pole mounted cabinet shall contain four light panels; one at the top of the rack assembly and one at the bottom rack assembly on each side of the cabinet. A second door open status switch per door shall activate a controller input to log a report event that one of the doors was opened. All door open status switches shall be connected to the same controller input. For the ground mount cabinet, there shall be two switches on each of the four main doors. For the side-of-pole mount cabinet, there shall be two switches on each of the two main doors..

The cabinet shall be provided with a thermostatically controlled ventilating fan(s) and air filters. 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 ventilating system shall meet the following requirements:

- be designed to prevent the entrance of rain, snow, dust, and insects.
- Two fans shall be supplied and installed for the ground mount cabinet and one fan shall be supplied and installed for the pole mounted cabinet. The electric fan shall have ball or roller bearings and shall have a capacity of 100 ft<sup>3</sup> per minute. The fans shall be rated for continuous duty with a minimum service life of 3 years. The fan blades shall be supplied with a safety screen to prevent accidental contact with the blades.
- The air intake vents shall be rain tight and covered with a removable glass fiber filter. There shall be two intake vents provided with the ground mount cabinet and one intake vent supplied with the pole mount cabinet. The removable air filter shall be firmly held in place such that cracks and openings are eliminated to ensure that all air is filtered.
- The thermostat shall be mounted on the top interior of the cabinet and user adjustable to allow for temperature settings from a minimum of 70°F to 140°F and capable of activating the fans within plus or minus five degrees of the set temperature.

The cabinet shall contain a pull-out drawer, 19" wide with sufficient strength to hold a laptop computer. The top of the drawer shall be covered with a non-conductive, non-skid material and hinged such that a storage space is available to store cabinet documentation or small parts. The pull-out shelf shall be located in the rack space directly under the controller unit. The back of the control side

front door shall contain a resealable, heavy-duty opaque plastic envelope with two grommets that provide mounting to two integrated hooks installed on the back side of the front cabinet door. The heavy-duty plastic envelope will be used to store cabinet wiring diagrams and operations manuals that cannot be accommodated in the pull-out draw storage tray.

The cabinet main doors shall be provided with a stop to limit door opening to both 90° and 180° ±10°. The door stop bar shall be a captive type mechanism that serves to keep the bar in contact with the cabinet at both stop bar ends and provided with a catch that can be operated when the door reaches these 2 positions and will hold the door open securely until released. The cabinet shall be supplied with a three-point draw roller latching system consisting of the following latching points:

- Center of the cabinet (lock)
- Top of the cabinet- controlled by door handle
- Bottom of the cabinet - controlled by door handle

The latching points on the top and bottom of the cabinet door shall remain in the locked position until the door lock is disengaged. The locking mechanism shall be equipped with nylon rollers to secure the top and bottom of the door.

The cabinet shall be supplied with a ¾" diameter shank, stainless steel latching handle for each door. The latching handle shall have a provision for padlocking the door in a closed position.

The cabinet main doors hinge pins shall be made of stainless steel.

The locks for the switch compartment door of the cabinet shall unlock with a skeleton style (#1) key. The locks for the main doors of the cabinet shall unlock with a Corbin #2 key. One set of keys shall be furnished with each cabinet.

The cabinet shall be supplied with a permanent label mounted on the upper portion of the inside front main door which contains the name of the cabinet manufacturer, controller manufacturer, model/part number and year/month of assembly.

The cabinet shall be supplied with a laminated door sticker. This sticker shall be permanently affixed to the inside front control side of the cabinet door for the ground mount cabinet and the inside front side of the pole mount cabinets. At a minimum, the sticker shall contain the following information:

- Vehicle detection information including detector channel assignment, phase assigned, approach and cabinet termination points.
- If applicable, network communications information for all in-cabinet devices. This includes IP addresses, subnet mask and MAC address.
- Per approach preemption information including channel, approach/direction and termination points.

- Field termination chart showing per approach/per phase numbering of all signal circuits.
- Signal phasing and signal plan with intersection geometry and signal head designations.

The main cabinet circuit breaker shall be rated at 30 amps. 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 0 to +158°F.

### ***Auxiliary Equipment Requirements***

The cabinet shall be supplied with a global positioning system (GPS) antenna to provide an accurate time reference for the cabinet. The antenna shall be mounted at the top of the cabinet in the back-left corner of the enclosure. The antenna shall be mounted such that it provides a waterproof seal; eliminating any possibility for water penetration into the cabinet. The GPS system cable shall be connected and integrated into the controller.

The cabinet shall be supplied with a generator panel. The generator panel shall consist of a manual transfer switch and a twist-lock four prong connector for generator hookup. The transfer switch knob and twist-lock connector shall be located inside a generator access panel with a separate lockable door mounted on the lower left, exterior of the control side wall of the ground mount cabinet and on the lower left side of the pole mounted cabinet. The door shall be equipped tamper resistant hinge. The generator panel assembly shall be housed in a heavy-duty, vandal resistant, weatherproof, dustproof enclosure designed for exterior applications. The generator access panel door shall have a moveable plate to cover an opening for the generator cable. The connection to an external generator shall be a waterproof, secure connection. The connection shall allow authorized personnel; to access, connect and secure an external electrical source to the cabinet for power restoration. The generator panel door shall contain a weather proof seal and supplied with a lock accessed with a J201 key. The generator transfer switch shall be a Reliance C30A1N Signa Series or approved equal

The cabinet shall be supplied with a GFI outlet to be installed on the upper left, exterior of the control side wall of the ground mount cabinet and the upper left side of the pole cabinet. The electrical outlet will be GRCI protected, house in a locked access enclosure. The GFI outlet shall be supplied via its own 15 amp circuit breaker. The GFI outlet assembly shall be housed in a heavy-duty vandal resistant, weatherproof, dustproof enclosure designed for exterior applications. The GFI enclosure door shall contain a weather proof seal and supplied with a lock accessed with a Corbin #2 key.

The cabinet shall be supplied with detector test switch panel. This panel shall be rack mounted and located above the controller. There shall be a total of 12 switches to allow for the manual placement of detector calls into the controller. Each switch shall be clearly labelled as to input channel and function. Each switch position shall correspond to the same controller input; switch one is for controller input channel one, switch two is for controller input channel 2, etc. Switches 1-8 shall correspond to phase 1-8 vehicle calls. Switches 9-12 shall correspond to pedestrian calls 2, 4, 6 and 8. The switch labels shall define the corresponding vehicle or pedestrian phase called and switch position function. Detector switches shall be three position and function as follows:

- Up Position= Provides a constant call
- Center Position= Normal operation (Phase receives call from detectors)
- Down Position = Provides a momentary call

A Cabinet Monitor Unit (CMU) and Auxiliary Display Unit (ADU) shall be supplied and installed in each cabinet. The CMU and ADU shall conform to requirements defined in the Advanced Transportation Controller Cabinet (ATCC) 5301 v02 standard. The CMU/ADU units shall support 32 channels. All configuration programming shall be resident in a non-volatile Datakey device. Each CMU shall be supplied with a Datakey programmer and associated software. The Datakey programming software shall include a set-up wizard which shall assist the user with the initial set up of the device. The Contractor shall program the Datakey with data entries appropriate for each intersection. All programming resident on the Datakey shall be included in the hardcopy.

The cabinet 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 cabinet 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 resident on the cabinet monitor unit.

A cabinet power supply shall be supplied with each cabinet. The cabinet power supply shall comply with ATCC 5301 v02 (EDI Model 2216-2412-HV or equivalent).

A GFCI duplex outlet and two multi-outlet strips shall be supplied with each cabinet and connected to clean power.

A full complement of switch packs shall be supplied with each cabinet. Switch packs shall comply with ATCC 5301 v02.

A full complement of SIUs shall be supplied with each cabinet. The Serial Interface Units (SIU) shall comply with ATCC 5301 v02.

A full complement of flashers shall be supplied with each cabinet. Flashers shall comply with ATCC 5301 v02. The field electrical loading for flash operation shall be wired through the transfer relays such that the load on the 2-circuit flasher is as balanced as possible within the limitations of the signal phasing.

A full complement of flash transfer relays shall be supplied with each cabinet. Flash transfer relays shall comply with ATCC 5301 v02.

In addition to the full complement of switch packs, SIU's, flashers, and flash transfers relays, two additional SIU's shall be supplied. All spare equipment required to be supplied with the ground mounted cabinet shall be stored in the spare equipment rack. Spare equipment required to be supplied with the pole cabinet shall be delivered to MaineDOT.

Electrical filtering/surge protection shall be supplied and installed in each cabinet in accordance with ATCC 5301 v02 requirements and the manufacturer's recommendations. At a minimum, surge suppression shall be provided for incoming electric utility power conductors, all signal control circuits, vehicle detection, pedestrian detection, communications and preemption system terminations.

Three copies of the database programming for all in cabinet devices shall be provided with each cabinet. The database programming sheets shall reflect as-built programming resident in each unit at the time of acceptance.

The Contractor shall reconfigure the default user name and passwords on all communications / control equipment within the ATC Controller and Cabinet. This includes but is not limited to the ATC traffic controller, ATC ancillary equipment, video detection equipment, Ethernet switches, and routers. The new user name and passwords shall be created in coordination with the MaineDOT Traffic Division staff and or as directed by the engineer; no manufacture default level passwords shall be allowed. The Contractor shall utilize network communications encryption settings on all forms of wired Ethernet data paths. No "in the clear" communications shall be allowed. At a minimum all wired Ethernet connections shall meet 802. IAE standards. The Contractor shall supply and configure a Cyber Intrusion and Prevention Device (CIPD) in each ATC cabinet. The CIPD shall prevent any unauthorized access/ connections to the traffic control system. Upon detection of unauthorized attempts, the CIPD shall notify the agency via SMS message and or email and log the event. The CIPD shall be installed prior to any remote access device. The Contractor shall coordinate with the agencies Information Technology and Operational Technology (IT/OT) staff and or the engineer for finale configuration of the CIPD. No direct access to the traffic system shall be allowed without the installation of a CIPD and or Router/Firewall.

### ***Cabinet Testing Requirements***

The testing process is required to ensure that the controller and cabinet assembly perform properly and meet all requirements described and required as part of this project have been met. This includes testing of all hardware and all software supplied and installed as part of this project. All tests shall be conducted in accordance with the approved test procedures developed by the Contractor. The Contractor shall submit test procedures and forms/checklists for review and approval to the Engineer.

All components of the controller and cabinet shall be bench tested for a minimum of 72 continuous hours by the Contractor at the Contractor's facility prior to delivery to the project. Testing shall be performed by an IMSA, level 3 (Field or Bench) Certified Signal Technician using a test board and in conformance with the design loads, phasing, timing and auxiliary equipment such as pre-emption. Upon completion of satisfactory bench testing, a written approval will be supplied to the Contractor by the Engineer. This approval does not relieve the Contractor from ensuring proper operation of the equipment. The approval shall accompany the cabinet and controller when delivered to the project.

The Contractor shall supply vendor specific or any test specific software for testing, as needed, at no additional cost.

At a minimum, the test plan developed by the Contractor shall contain the following sampling of test items:

- a) Installation of all the equipment into the cabinet as required per the plans and specifications.
- b) Setting of the phase timings of the controller in accordance with plans.
- c) Checking all of the wiring connections for physical tightness.
- d) Observing the sequences, timings and operations of the controller to verify conformance to the plans and specifications.
- e) Test the police panel switches installed in the panel.
- f) Test Pre-emption and/or Priority operation - Optical Detector - with the receivers wired in the cabinet and using an emitter, test each pre-emption or priority run as per the plans. Hard Wired - Attach a temporary push button as per the plans and test each pre-emption or priority run as per the plans.
- g) Check exhaust fan controls by applying heat from a 100-watt lamp on an extension cord to the thermostat.
- h) Check heat lamp controls by cooling the thermostat.
- i) Check cabinet monitor unit by testing for any conflicting Greens or Yellows by the use of a jumper wire attached to a displayed Green or

Yellow and to the other non-parent Greens or Yellows to ascertain that conflicting colors are not present. Test all possible combinations of conflicting displays.

Upon completion of the project, a print out of the databases contained in the controller, CMU, Preemption, Video Detection or any other equipment shall be provided to the Engineer. The databases shall be provided either via a hard copy printout or on a "thumb drive."

Tests shall be conducted by the Contractor, witnessed by the Engineer, at the Contractor's facility. The test facility shall be clean, heated/air conditioned and have provisions for the simultaneous testing of at least three (3) controller and cabinet assemblies. The controller and cabinet assembly shall be wired and programmed to provide the signal phasing, timing and operations shown on the design plans for that particular location. A test light board and a manual detector call panel shall be connected to each cabinet assembly to verify display outputs and vehicle/pedestrian input calls.

This test plan, when approved and executed, must demonstrate that the controller and cabinet assembly meet all of the requirements contained in the project Plans and Specifications.

The Contractor shall propose testing plans and submit the test plan(s) and procedures as detailed herein to the Resident and Design Engineers for approval prior to testing. Each of the test plans shall contain the following elements:

- Proposed date, time, and location of the testing
- Names of the Contractor personnel who will be conducting the testing
- Descriptive overview of the proposed test procedure
- List of test equipment required to perform the testing
- Test cases and test logging forms which detail every step of the test procedure:

Test logging forms shall be presented in tabular format, with separate columns for each of the following:

- Test case description detailing the test step to be performed.
- Expected result
- Actual result
- Pass/fail
- Comments

The Contractor shall supply separate test logging forms at the time of testing for each test plan, and for each device location. The test logging forms shall show the device location, date, and the start and end times of the test.

At the end of each test logging form, there shall be signature and date locations for each of the following:

- Contractor personnel conducting the test
- MaineDOT representative witness
- Engineer witness

Signatures on the test logging form will signify only that the test was performed and witnessed, not that it passed or failed.

The detailed Test Plans shall be submitted to the Engineer no later than 30 Days prior to the beginning of each test phase.

The Contractor shall have approved test plans prior to submitting a request to schedule the start of any test activities. The Contractor shall notify the Engineer no less than 14 Days prior to the beginning of any equipment or systems testing.

Testing shall provide verification and documentation that all requirements included in the Contract Documents are met. The Test Plans shall be developed by the Contractor to provide a mechanism that ensures that all contract requirements have been tested fully and verified.

If any deviations or changes to the approved Test Plans arise, it shall be resubmitted by the Contractor for review and approval by the Engineer at least 14 Calendar Days prior to any planned test activity stage. No tests shall be conducted until the Engineer have approved the test plan.

A summary of all tests shall be produced at the completion of each testing phase of the project to ensure that all requirements defined by the system are satisfied.

MaineDOT reserves the right to examine and test or retest any or all materials furnished by the Contractor for the project to determine if they meet the requirements specified within the Contract Documents.

If MaineDOT decides that any material used in the construction of this project is defective or otherwise unsuitable, and the workmanship does not conform to the requirements of this Contract, the Contractor shall replace such defective parts and material at no cost to the Project.

The times and dates of the tests shall be approved by the Engineer. The Contractor shall conduct all tests in the presence of the Engineer. Testing shall take place only on weekdays, which are official working days, unless the Engineer allows the test to be conducted and/or continued on weekends and non-working days. The Contractor shall make a request in writing at least 14 Days prior to the proposed testing, and schedule tests only if permission is granted by MaineDOT in writing.

The Contractor shall be responsible for the conduct and documentation of the results of these tests that will be countersigned by the Engineers at the end of each test. The signature of the Engineer implies only proof of presence. Test results shall be packaged and submitted to the Engineer within one week of test

completion. No test phase shall begin until all prior test phases have been completed, and test results have been approved by the Engineer.

718.09 **Flasher** - The flasher shall be a two circuit solid state 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 -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 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 8 ft by 5/8" 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.

- 718.13 **Non-Invasive Detection - Stop Bar** - The Stop Bar Vehicle Detection (SBVD) system shall detect vehicles on a roadway and send detector outputs to the traffic signal controller. All identical components of the SBVD system supplied by the Contractor as part of this project shall be from the same manufacturer and

be the same make, model, and firmware revision. The proposed SBVD system shall be consistent with the recommendations in the “MaineDOT Procedure for Traffic Signal Design and Operation”, notably the accepted vendors and systems for vehicle detection systems.

The SBVD system, at a minimum, shall:

- be non-intrusive (i.e. above ground) and shall consist of:
  - Mounting Brackets.
  - IP based traffic sensor assemblies, detection module, and/or cabinet interface device. (non-video based traffic sensors shall only be required to provide IP based cabinet interface device). Analog based cameras with separate video encoders shall not be allowed.
  - Communications Cable.
- be connected to the ethernet switch or the field monitor unit and all communications shall be routed IP based electronically through the field monitor unit (FMU) or ethernet switch. The use of external communication methods such as other cellular modems or connections to internet service provider modems must be routed through the FMU and shall not be allowed within the internal network of the ATCC.
- be powered through one of the power outlets available on the FMU. It is the intent that the SBVD system can be powered down and restarted through remote control of the power outlet on the FMU.
- be capable of detecting if and when vehicles, bicycles, and pedestrians are in a designated area and be able to place a call through the in-cabinet serial interface unit (SIU) bus to the appropriate detector channel within the traffic signal controller.
- be able to determine if the system’s ability to accurately detect vehicles is compromised and shall fault in an “always on” state.
- collect, store, and report signal performance data consistent with the following requirements:
  - The SBVD system shall be able to track and classify vehicles, bicycles, and pedestrians to determine turning movements. The system should have a documented history of being at least 95% accurate in similar conditions to the project location. If a documented history cannot be provided, then it will be the contractor’s responsibility to coordinate a demonstration of the proposed SBVD system consistent with the testing requirements in this specification before the submittal of the proposed SBVD system will be approved.

- The SBVD system shall be able to classify the vehicles based on estimated length.
- The SBVD system shall be capable of storing the relevant vehicle based signal performance data in a vehicle by vehicle format. If this is not possible for all data types, then data may be summarized into five minute or lower bins on a case-by-case basis.
- The SBVD system shall be capable of automatically collecting the signal performance data and shall be able to store the data for a period of at least 12 months on the detection module or cabinet interface device without an external connection to the internet.
- The SBVD system shall allow for the retrieval of signal performance data through an ethernet based connection to the detection module or cabinet interface device either in the field or through the internal network of the ATCC.
- If the location has been identified the intersection as a high-priority SPM intersection on the plans, then the SBVD system will have the following additional requirements:
  - The SBVD system shall monitor and record the status of the phase channels and detector channels from the traffic signal controller through the SIU bus at a frequency of no less than 10 times per second.
  - The SBVD system shall be able to classify vehicles consistent with the “MaineDOT Data Collection Guidelines”.
  - The SBVD system shall be able to estimate the speed of vehicles at defined user configurable points, such as entering or exiting a detection zone.
  - The SBVD system shall allow for the retrieval of signal performance data through a http based application programming interface (API), or equivalent automated process, in “xml”, “json”, or “csv” formats. The signal performance data shall be available in a per vehicle format, be viewable in real time, and store at least 168 hours of data locally on the device.
- be compatible with ATCC 5301 v02 standards.
- be compatible with ATC 5201 v06 standards.
- be able to operate without degradation over a temperature range of -40 to 165°F at a relative humidity up to 95% non-condensing.

- provide remote access to the latest available image or digital video stream of all IP video detection units installed at the intersections through either a HTTP request or through a Real Time Streaming Protocol (RTSP) compatible with RFC2326 standards. Detection systems that do not utilize video shall be able to display the current state of the vehicle detection zones and approximate vehicle locations in a digital twin model of the intersection.
- support remote configuration of the SBVD system settings such as adding and removing users and the configuration of the detection module and/or cabinet interface device through an ethernet based connection to the detection module or cabinet interface device either in the field or through the internal network of the ATCC.
- support remote configuration of the vehicle, bicycle, and pedestrian detection configuration including:
  - The number, location, and size of detection zones.
  - Configuration of the detector channel and assigned phase for each zone.
  - Configuration of detection zones for signal performance measure data collection.
- have user-based restrictions in place to limit functionality including:
  - The ability to view imagery or digital video streams.
  - The ability to make changes to the SBVD system settings.
  - The ability to view and download signal performance data.

### ***Construction Requirements***

The Contractor shall be responsible for furnishing all training, labor, materials, cables, connectors, tools, equipment, shipping, and incidental items necessary to complete the installation and make the non-invasive stop bar vehicle detection system fully operational.

Installation of the non-invasive stop bar vehicle detection system shall include the installation of any and all associated equipment including, but not limited to, the following:

- ***Traffic Sensor Assembly*** - The Contractor shall furnish traffic sensor assemblies per manufacture requirements, either one sensor per approach or two or more 360-degree sensors per intersection. The traffic sensor assembly(s) shall be affixed to the support structure in accordance with the manufacturer's instructions to provide the optimal field of detection.

- **Detection Module or Cabinet Interface Device** - The Contractor shall furnish one detection module or cabinet interface device per cabinet.
- **Detector Cable** - The Contractor shall furnish the specified cable type, all connectors, sealing tape and incidental work necessary to complete the installation of the connector cable between the traffic sensor assembly and the detection module or cabinet interface device.
- **Mounting Brackets and Ancillary Equipment and Labor** - The Contractor shall furnish detector mounting brackets and all associated equipment labor, materials, and incidental work necessary to attach the detector assemblies to a mast arm or extension bracket, complete the installation and make the SBVD system fully operational. All equipment shall be installed and wired in a neat and orderly manner in conformance with the manufacturer's instructions.
- The Contractor shall install the SBVD system software on any number of computers/systems as required by MaineDOT and the Engineer to allow visual confirmation of the detection zones as shown on the plans.
- The traffic sensor locations shown on the Plans are for illustrative purposes only. The final locations for the traffic sensors shall be located in the field and shall be approved by MaineDOT and/or the Engineer. The Contractor may be required to adjust and readjust the location of existing and proposed vehicle detection zones in the presence of the Engineer, at no additional cost, to verify that the SBVD system is accurately detecting traffic, including correct calls to the desired detection channels and a lack of false calls on non-desired detection channels.

After the SBVD system is installed in the field and operational, the MaineDOT and/or the Engineer will evaluate the signal performance data collected by the system to verify if the system meets the requirements within this specification. At a minimum, the turning movement counts collected by the SBVD system will be compared to turning movement counts collected by other means and the MaineDOT reserves the right to require testing of other requirements. The comparison turning movement counts should meet the following criteria:

- At least two 30 minute periods collected at different times of day, including at night.
- The turning movement counts should not be collected with inclement weather.
- The turning movement counts should be collected under moderate traffic.

If the MaineDOT and/or the Engineer determines that the SBVD system does not meet one or more of the requirements within this specification then the Contractor may be required to adjust the location, orientation, or number of the

traffic sensor assemblies and/or adjust the location of the vehicle detection zones. Upon which the SBVD system will be reevaluated.

Installation will be considered complete when the Contractor shows the system successfully and consistently places a request to the controller to call and extend the appropriate phase based on a vehicle detected in the detection zone, remote access to the SBVD system, and the SBVD system requirements have been verified.

- 718.14 **Non-Invasive Detection - Advance** - The Advance Vehicle Detection (AVD) system shall detect vehicles on a roadway and send detector outputs to the traffic signal controller. All identical components of the AVD system supplied by the Contractor as part of this project shall be from the same manufacturer and be the same make, model, and firmware revision. The proposed AVD system shall be consistent with the recommendations in the “MaineDOT Procedure for Traffic Signal Design and Operation”, notably the accepted vendors and systems for vehicle detection systems. No additional hardware, software items and/or subscription fees/costs shall be needed/allowed to satisfy the requirements as defined in these specifications.

The AVD system, at a minimum, shall:

- be non-intrusive (i.e. above ground) and shall consist of:
  - Mounting Brackets.
  - IP based traffic sensor assemblies, detection module, and/or cabinet interface device. (non-video based traffic sensors shall only be required to provide IP based cabinet interface device). Analog based cameras with separate video encoders shall not be allowed.
  - Communications Cable.
- be connected to the ethernet switch or the field monitor unit and all communications shall be routed IP based electronically through the field monitor unit (FMU) or ethernet switch. The use of external communication methods such as other cellular modems or connections to internet service provider modems must be routed through the FMU and shall not be allowed within the internal network of the ATCC.
- be powered through one of the power outlets available on the FMU. It is the intent that the AVD system can be powered down and restarted through remote control of the power outlet on the FMU.
- be capable of detecting if and when vehicles, bicycles, and pedestrians are in a designated area and be able to place a call through the in-cabinet serial interface unit (SIU) bus to the appropriate detector channel within the traffic signal controller. The system should have a documented history of being at least 95% accuracy of determining if one or more

vehicles, bicycles, or pedestrians are within the designated area in similar conditions to the project location. If a documented history cannot be provided, then it will be the contractor's responsibility to coordinate a demonstration of the proposed AVD system consistent with the testing requirements in this specification before the submittal of the proposed AVD system will be approved.

- be able to determine if the system's ability to accurately detect vehicles is compromised and shall fault in an "always on" state.
- be compatible with ATCC 5301 v02 standards.
- be compatible with ATC 5201 v06 standards.
- be able to operate without degradation over a temperature range of -40 to 165°F at a relative humidity up to 95% non-condensing.
- provide remote access to the latest available image or digital video stream of all IP video detection units installed at the intersections through either a HTTP request or through a Real Time Streaming Protocol (RTSP) compatible with RFC2326 standards. Detection systems that do not utilize video shall be able to display the current state of the vehicle detection zones and approximate vehicle locations in a digital twin model of the intersection.
- support remote configuration of the AVD system settings such as adding and removing users and the configuration of the detection module and/or cabinet interface device through an ethernet based connection to the detection module or cabinet interface device either in the field or through the internal network of the ATCC.
- support remote configuration of the vehicle, bicycle, and pedestrian detection configuration including:
  - The number, location, and size of detection zones.
  - Configuration of the detector channel and assigned phase for each zone.
  - Configuration of detection zones for signal performance measure data collection.
- have user-based restrictions in place to limit functionality including:
  - The ability to view imagery or digital video streams.
  - The ability to make changes to the SBVD system settings.
  - The ability to view and download signal performance data.

### **Construction Requirements**

The Contractor shall be responsible for furnishing all training, labor, materials, cables, connectors, tools, equipment, shipping, and incidental items necessary to complete the installation and make the non-invasive advance vehicle detection system fully operational.

Installation of the non-invasive advance vehicle detection system shall include the installation of any and all associated equipment including, but not limited to, the following:

- **Traffic Sensor Assembly** - The Contractor shall furnish traffic sensor assemblies per manufacture requirements, either one sensor per approach or two or more 360-degree sensors per intersection. The traffic sensor assembly(s) shall be affixed to the support structure in accordance with the manufacturer's instructions to provide the optimal field of detection.
- **Detection Module or Cabinet Interface Device** - The Contractor shall furnish one detection module or cabinet interface device per cabinet.
- **Detector Cable** - The Contractor shall furnish the specified cable type, all connectors, sealing tape and incidental work necessary to complete the installation of the connector cable between the traffic sensor assembly and the detection module or cabinet interface device.
- **Mounting Brackets and Ancillary Equipment and Labor** - The Contractor shall furnish detector mounting brackets and all associated equipment labor, materials, and incidental work necessary to attach the detector assemblies to a mast arm or extension bracket, complete the installation and make the AVD system fully operational. All equipment shall be installed and wired in a neat and orderly manner in conformance with the manufacturer's instructions.
- The Contractor shall install the AVD system software on any number of computers/systems as required by MaineDOT and the Engineer to allow visual confirmation of the detection zones as shown on the plans.
- The traffic sensor locations shown on the Plans are for illustrative purposes only. The final locations for the traffic sensors shall be located in the field and shall be approved by MaineDOT and/or the Engineer. The Contractor may be required to adjust and readjust the location of existing and proposed vehicle detection zones in the presence of the Engineer, at no additional cost, to verify that the AVD system is accurately detecting traffic, including correct calls to the desired detection channels and a lack of false calls on non-desired detection channels.

After the AVD system is installed in the field and operational, the MaineDOT and/or the Engineer will evaluate the signal performance data collected by the

system to verify if the system meets the requirements within this specification. At a minimum, the detector output status will be compared to traffic data collected by other means and the MaineDOT reserves the right to require testing of other requirements. The comparison should meet the following criteria:

- Should be at least 30-minutes of visual evaluation of the detection system under live traffic.
- Should not be collected with inclement weather.
- Should be collected under moderate traffic.

If the MaineDOT and/or the Engineer determines that the AVD system does not meet one or more of the requirements within this specification then the Contractor may be required to adjust the location, orientation, or number of the traffic sensor assemblies and/or adjust the location of the vehicle detection zones. Upon which the AVD system will be reevaluated.

Installation will be considered complete when the Contractor shows the system successfully and consistently places a request to the controller to call and extend the appropriate phase based on a vehicle detected in the detection zone, remote access to the AVD system, and the AVD system requirements have been verified.

718.15 **Field Monitoring Unit (FMU)** - This item of work shall conform to this specification. This item shall consist of furnishing and installing a FMU and software, as well as all needed accessories required for a full and complete installation, including but not limited to power adapters, Ethernet cables, and interface cables, as described herein.

Where applicable, communications from MaineDOT's cloud-based Central Management System (CMS) to the on-street traffic signal controllers shall be made through fiber optic interconnect cable connected back to existing internet connections and/or the FMU. The Contractor shall furnish and install all materials necessary for a complete and operational fiber optic interconnection to all Project intersections as shown on the plans. All connections to the CMS cloud-based system shall be via a secure VPN network.

The FMU shall be the only remote connection device used by isolated intersections to connect to the cloud-based system. All connections shall be encrypted VPN tunnels. The Contractor shall coordinate all configuration settings with MaineDOT Traffic Division and the Engineer.

The FMU central web based interface shall be a separate element from the CMS.

**Materials** - The materials for this work shall conform to the following requirements:

1. The work under this item specifies the requirements for the FMU. The FMU shall operate independent of the brand/type of intersection controller deployed in the ATC traffic cabinet.

2. The FMU shall conform to the following requirements:
  - 2.1 The FMU shall function correctly between -34°C and +74°C.
  - 2.2 The FMU shall be provided with appropriately rated connectors that allows the FMU to be exchanged by unplugging connectors, without tools.
  - 2.3 The FMU shall monitor and log all ATC Controller and ATC cabinet faults and or alarms.
  - 2.4 The FMU shall be wired directly to the ATC cabinet.
  - 2.5 The FMU shall have an internal cellular modem running at 4G LTE.
    - 2.5.1 The Cellular modem shall be designed to be replaced / upgraded to 5G service when available.
  - 2.6 The FMU shall incorporate an integrated GPS and cell modem.
  - 2.7 The configuration of the FMU shall be accomplished by accessing the internal web server with a browser. It shall be possible to configure the FMU without any special software.
  - 2.8 The FMU shall be powered via a standard 120V input power.
  - 2.9 The FMU shall allow for the routing of the controller configuration packets to and from the controller (either by Ethernet or serial communications) for any type of controller utilized by the MaineDOT. In this way it shall be possible to configure the controller and utilize the controller specific software to interrogate the controller, and the FMU shall provide the communications pipe which allows this to be accomplished.
  - 2.10 The FMU shall, within the size limitations above, include a battery and battery charging/monitoring circuit, to allow the FMU to function correctly even when all power to the intersection has failed. The battery shall continue to power the FMU for a minimum of 5 hours after all power has failed to the intersection.
  - 2.11 The FMU shall incorporate an integrated GPS which will allow the FMU to geo-locate itself on the FMU management software map, without configuration.
  - 2.12 The FMU shall operate without requiring a static IP address. The only configuration required at the FMU is to enter the URL of where the FMU management software is hosted.
  - 2.13 In the event that the cell service is interrupted or is not available, the FMU shall store any events that occur in internal memory and forward these events automatically to the FMU management software when the cell service is restored. In this way, a complete

record of events at the device can be maintained even if cell service is interrupted for a period. The system will store 5000 events.

- 2.14 The FMU shall utilize HTTP and HTTPS protocols, and XML data structures, for communication with the FMU management software. In this way the data will be open for future expansion and competition. The use of secret proprietary protocols is not permitted.
  - 2.15 The FMU shall include Ethernet communications via an Ethernet Port with RJ45 connector.
  - 2.16 The FMU shall include weather proof antennas.
3. Map Display FMU Management Software
    - 3.1 The FMU shall include a scrollable, zoomable map display, with the intersections and other monitored devices shown as representative icons on the map. The map shall include the ability to see the intersections using Google Streetview.
    - 3.2 The alarm status of the intersection shall be clearly indicated on the icon on the map, so that the user can see at a glance which intersections are in alarm.
    - 3.3 The map display shall also include a list of intersections, with the number and priority of alarms indicated on the list. Intersections in high priority alarm shall be moved to the top of the list, followed by medium priority, low priority and then finally by intersections not in alarm.
    - 3.4 The icons shall change to be able to clearly indicate if an intersection is offline.
    - 3.5 Clicking on the icon on the map shall expose a box with the current parameters of the intersection shown.
    - 3.6 The default map display position and zoom shall be configurable by user, so that the user's view will default to show the intersections that the user is responsible for managing.
    - 3.7 The map view shall have the ability to show Google traffic overlays on the map.
  4. Intersection Detail Display FMU Management Software.
    - 4.1 It shall be possible to drill down, either from the map icon or from the list, to a device level detail for the intersection, which as a minimum shall display the following parameters:
      - 4.1.1 The alarm status, with priority indicated, and a text description of the alarm (if an alarm is present for this device).

- 4.1.2 The time since the last communication with the device
  - 4.1.3 The following parameters (real time now values, minimum for the Day values, maximum for the Day values, and average for the Day values).
    - 4.1.3.1 The AC mains voltage (value)
    - 4.1.3.2 The battery back-up voltage (value)
    - 4.1.3.3 The cabinet temperature (value)
    - 4.1.3.4 The cabinet humidity (value)
    - 4.1.3.5 The presence of AC power (OK or Fail)
    - 4.1.3.6 The flashing status of the intersection (OK or Flashing)
    - 4.1.3.7 Stop Time status (OK or Stop Time Active)
    - 4.1.3.8 The cabinet door status (Open or Closed)
    - 4.1.3.9 The intersection fan status (Fan On or Fan off)
  - 4.1.4 It shall be possible to view graphs of each of the value parameters in graphical form, over the recent 2 week period. This includes real time graphs of:
    - 4.1.4.1 The AC mains voltage
    - 4.1.4.2 The battery back-up voltage
    - 4.1.4.3 The cabinet temperature
    - 4.1.4.4 The cabinet humidity
5. Diagnostics and Log Display FMU Management Software
- 5.1 From the device level detail within the FMU management software, it shall be possible to drill down to get the raw data; the error logs; and the communications logs to allow a technician to fault-find problems.
  - 5.2 It shall be possible to filter the logs by Device; by Device Type and/or by Group as well as between dates.
  - 5.3 It shall be possible to print these selected logs to a local printer or a PDF file.
  - 5.4 It shall be possible to export these logs to Excel on the local computer for further analysis.
6. Alarms FMU Management Software
- 6.1 The FMU management software shall have a comprehensive alarm generation capability

- 6.2 It shall be possible to configure alarms to be generated on any parameter becoming out of tolerance, including analog values, digital values and enumerated values.
  - 6.3 Alarms shall be configurable to be of Low, High or Critical Priority.
  - 6.4 The alarm priority shall be displayed throughout the FMU management software, on all displays, using color codes such as red-critical; yellow – high; and amber-low to indicate the priority of the alarm.
  - 6.5 The current active alarms shall be accessible for view via an expandable window, to see which alarms are active and when the alarm occurred. The highest priority alarms shall rise to the top of the list.
7. Alerts FMU Management Software
- 7.1 The FMU management software shall have comprehensive alerting capability, to enable the response personnel to be notified when an abnormal situation has occurred.
  - 7.2 It shall be possible to configure alerts to one or more personnel for each alarm. This will cause, as selected, an SMS and/or an email to be sent to the person when an alarm occurs.
  - 7.3 The alert shall be configurable to optionally send via email and/or via SMS a message when an alarm clears.
  - 7.4 The intention is that the FMU management software provides the alerts to the user in near real time. The SMS and email shall be issued within 30 seconds of the occurrence of event which results in an alert being issued.
8. Hosting and Connectivity and Service FMU / FMU Management Software
- 8.1 The Contractor shall supply the FMU with the FMU manufacturers 10 year options for Connectivity and Service, as part of the purchase price. The Connectivity and Service agreement shall include at a minimum:
    - 8.1.1 Cellular Connectivity
    - 8.1.2 No cellular overage charges
    - 8.1.3 Extended warranty on the hardware for the period of the Connectivity and Service Agreement
    - 8.1.4 Over-the-air software updates
    - 8.1.5 Over-the-air security updates
    - 8.1.6 Future Connected Vehicles Service

## 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 be AASHTO Product Evaluation & Audit Solutions tested and conform to all the requirements of FHWA ASTM D4956, Standard Specification for Retroreflective Sheeting for Traffic Control, including supplementary requirements. Engineering grade reflective sheeting shall meet the reflective intensity requirements of ASTM D4956, Standard Specification for Retroreflective Sheeting for Traffic Control, including supplementary requirements Type II sheeting. High intensity prismatic reflective sheeting shall meet the reflective requirements for ASTM D4956 Type III prismatic sheeting.

Reflective sheeting, used in sign construction, shall be from the Department's Qualified Products List and have been manufactured within the 6 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.

Super high intensity fluorescent retro-reflective sheeting, ASTM D4956 - Type VIII, or Type IX (prismatic), is required for all construction signs.

**EXAMPLE TABLE**

Engineering Grade	Type II
High Intensity	Type III
Work Zone	Type VIII or Type IX (prismatic)

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

- 719.02 **Demountable High Intensity Prismatic Reflectorized Letters, Numerals, Symbols and Borders** - Demountable reflectorized letters, numerals, symbols and borders shall consist of cut out high intensity prismatic sheeting, be AASHTO Product Evaluation & Audit Solutions tested and, conforming to FHWA, "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects," 2014 FP-14 718.0.
- 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 B221, 606-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 the 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 0.08" for signs of an area of 12 ft<sup>2</sup> or less and shall be 0.125" for signs over 12 ft<sup>2</sup> 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 60 lb/1,000 ft<sup>2</sup> surface, shall be at least 0.009" 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 5/8".
- 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 3" 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 ¼" square hole for center mounting. Double and triple delineators shall have two ¼" square mounting holes on the vertical centerline.

Single delineators shall be 3 by 3" diamonds with ¾" radius corners and two ¼" square mounting holes, 3" on center.

Double delineators shall be 3 by 6" rectangles with ¾" radius corners and two ¼" square mounting holes 5" on center.

The aluminum shall be 6061-T6, ASTM B209 or 6063-T6 or 6005-T5 0.063" 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 W6 by 9 steel beams conforming to the requirements of ASTM A992/A992M, galvanized in

accordance with AASHTO M 111 (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 5¼ 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 W6 by 9 shall not exceed approximately 3¼ ft.

On independent sign support structures, these 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. U-bolt hardware, which includes nuts, flat washers, and helical lock washers, shall be galvanized in accordance with AASHTO M 232 (ASTM A153), ASTM F2329, or ASTM B695, Class 50, Type I. 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 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/A194M, 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 356T-6 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).

719.075 **Roadside Signing** - Aluminum signs mounted on U-channel posts shall be fastened with 5/16 by 1½" 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 5/16 by 2½" 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 ¼ by 2¼" 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 B221 or ASTM B429, Alloy 6061-T6 or 6063-T6. Castings for use with aluminum supports shall conform to ASTM B26 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 shall conform to the current edition of AWS Structural Welding Code - Aluminum D1.2 (AWS D1.2).

All welds shall be inspected and conform with AWS D1.2, Clause 5, Inspection. 100% of welds shall be visually examined (VT). In addition to VT, 10% of all partial joint penetration (PJP) and fillet welds shall be dye penetrant tested (PT); locations to be PT examined will be designated by the QAI. 25% of complete joint penetration (CJP) welds shall be ultrasonic tested (UT) or PT based on the thinner

material in the welded joint; joints with thinner material thicknesses less than 0.25" shall be PT examined and joints with thinner material thickness equal or greater than 0.25" shall be UT examined. Locations to be UT examined will be designated by the QAI. Extent of testing shall conform with AWS D1.2, Clause 5.

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 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 0.188". A hand hole of approximately 25 in<sup>2</sup> in area, reinforced to maintain the full design strength of the shaft, shall be provided with the handhole center approximately 18" 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 ¼". 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 0.125" and the minimum diameter at the base shall be 5". The length of the shaft plus the base shall be 14¼ ft, with a 4" long by 3" 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 25 in<sup>2</sup> in area and equipped with an approved locking device on the handhole cover. The bases shall have internal flanges capable of accepting four ¾" anchor bolts, equally spaced on a 10" 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 6" and the minimum wall thickness shall be ⅛". The length of the pole plus the base shall be 10 ft, except that the length of poles supporting only pedestrian heads shall be 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 ⅛". 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 shall conform to the current edition of AWS Structural Welding Code - Aluminum D1.2 (AWS D1.2).

All welds shall be inspected and conform with AWS D1.2, Clause 5, Inspection. 100% of welds shall be visually examined (VT). In addition to VT, 10% of all partial joint penetration (PJP) and fillet welds shall be dye penetrant tested (PT); locations to be PT examined will be designated by the QAI. 25% of complete joint penetration (CJP) welds shall be ultrasonic tested (UT) or PT based on the thinner material in the welded joint; joints with thinner material thicknesses less than 0.25" shall be PT examined and joints with thinner material thickness equal or greater than 0.25" shall be UT examined. Locations to be UT examined will be designated by the QAI. Extent of testing shall conform with AWS D1.2, Clause 5.

- 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 A709, 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. 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 M 111.

Chord flange splice fastener assemblies shall conform to ASTM A325, Type 1, and galvanized in accordance with AASHTO M 232 (ASTM A153), ASTM F2329, or ASTM B695, Class 50, Type I. Other fastener assemblies shall be as specified in Section 719.07, or as approved by the Fabrication 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 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 25 in<sup>2</sup> in area, reinforced to maintain the full design strength of the shaft, shall be provided with the hand hole center approximately 18" 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 4" nominal ID, schedule 40 pipe without splices. The length of the pole plus the base shall be 10 ft, except that the length of poles supporting only pedestrian heads shall be 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 Resident 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 M 111. 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 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 Post shall conform to the requirements of ASTM A992. All work shall conform to the applicable provisions of Section 504 – Structural Steel. Steel shall be hot-dip galvanized in accordance with AASHTO M 111 (ASTM A123). All steel hardware for use with H-beam poles shall be galvanized in accordance with AASHTO M 232 (ASTM A153), ASTM F2329, or ASTM B695, Class 50, Type I.

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 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 6" minimum leg length at the lower end. The anchor bolts, nuts and hardened washers shall be galvanized in accordance with AASHTO M 232 (ASTM A153), ASTM F2329, or ASTM B695, Class 50, Type I. The bolt shall be zinc-coated 12" 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 anchor bolts subject to approval of the Fabrication Engineer.

720.08 **U-Channel Posts** - Except as otherwise authorized, Rib Back U-Channel posts for signs of less than 4 ft<sup>2</sup> in area, shall be fabricated of steel weighing 2 ½ lb/ft, and shall not be doubled-up. Aluminum U-channel posts having the same strength characteristics and shape as steel U-channel posts may be used, subject to the approval of the Resident. The steel U-channel posts shall be powder coat green in accordance with AASHTO M 111.

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 Resident .

The wood cross section shall be 10 by 10" minimum. The mounting height and depth of burial shall be as shown on the plans.

The following items shall be supplied, a 2" 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 galvanized in accordance with AASHTO M 232 (ASTM A153), ASTM F2329, or ASTM B695, Class 50, Type I.

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, Red Pine 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 4". Tops of poles shall be beveled.

Wood Utility poles shall be pressure treated, after fabrication in accordance with AASHTO Specifications M 133 and AWWA U1, UC4B, Commodity Specification D: Poles.

- 720.11 **Mast Arms for Wood Utility Poles** - All mast arms for wood Utility pole attachment shall be standard 2" 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 100 mph wind.

- 720.12 **Wood Sign Posts** - Wood sign posts shall be rectangular, straight and sound timber, cut from live growing native spruce, red pine, hemlock, cedar trees or other AWWA approved species, free from loose knots or other structurally weakening defects of importance, such as shake or holes or heart rot. A tolerance of 1" in length and ¼" 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** - 4 by 6" posts shall have two 1½" diameter holes drilled perpendicular to traffic, one hole centered at 4" above ground level and one centered at 18" above ground level (posts shall be installed with the 6" length parallel to the roadway); 6 by 6" posts shall have two 2" diameter holes drilled perpendicular to traffic, one hole centered at 4" above ground level and one centered at 18" above ground level; 4 by 4" posts need not be modified.

All sign posts shall be pressure-treated in accordance with AASHTO M 133 and AWWA Standard U1, UC4A, Commodity Specification A: Sawn Products.

## 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

- 722.00 **General Geotextile Property Requirements** - This is a materials specification covering geotextile fabrics for use in stabilization/reinforcement, drainage, erosion control and separation applications. This specification sets forth a set of physical, mechanical and endurance properties that must be met, or exceeded, by the geotextile being manufactured. This specification is intended to assure both good quality and performance of geotextiles but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive values for the tests indicated, may be necessary under conditions of a particular application. This specification is based on geotextile survivability from installation stresses. This Section is intended for use in conjunction with Section 620 - Geotextiles.

Table 1 provides strength properties for three geotextile classes. The geotextile shall conform to the properties in Table 1 based on the Geotextile Class required in the application specific sections which follow.

All Table 1 property values represent Minimum Average Roll Value (MARV) in the weakest principal direction and shall meet or exceed the values stated below. The geotextile properties required for each Class are dependent on geotextile elongation. (See Table on next page.)

**TABLE 1 - GEOTEXTILE STRENGTH PROPERTY REQUIREMENTS**

	Test Method <sup>a</sup>	Class 1 <sup>b</sup>		Class 2 <sup>b</sup>		Class 3 <sup>b</sup>	
		Elongation		Elongation		Elongation	
		<50% <sup>c</sup>	≥50% <sup>c</sup>	<50% <sup>c</sup>	≥50% <sup>c</sup>	<50% <sup>c</sup>	≥50% <sup>c</sup>
Grab Strength (lb)	D 4632	315	202	247	157	180	112
Sewn Seam Strength <sup>d</sup> (lb)	D 4632	283	182	223	142	162	101
Tear Strength (lb)	D 4533	112	79	90 <sup>e</sup>	56	67	40
Puncture Strength (lb)	D 6241	618	433	495	309	371	223
Other	Test Method <sup>a</sup>						
Conformance	D 4759						
Sampling and Testing	D 4354						
Storage and Handling	D 4873						
<sup>a</sup>	ASTM test method.						
<sup>b</sup>	Required geotextile class is designated in Tables 2, 3, 4, 5, or 6 for the indicated application. The severity of installation conditions for the application generally dictates the required geotextile class. Class 1 is specified for more severe or harsh installation conditions where there is a greater potential for geotextile damage, and Classes 2 and 3 are specified for less severe conditions.						
<sup>c</sup>	As determined in accordance with ASTM D4632. The strengths specified in the columns labeled “<50%” and “≥50%” refer to the elongation at which the geotextile material was tested. For example; if a fabric is tested at 15% elongation then it must meet or exceed the minimum strength shown in the “<50%” column. Submittals must include the percent elongation at which the material was tested.						
<sup>d</sup>	When sewn seams are required.						
<sup>e</sup>	The required MARV tear strength for woven monofilament geotextiles is 56 lb.						

722.01 **Stabilization/Reinforcement Geotextile** - The Stabilization/Reinforcement Geotextile shall meet or exceed the requirements of Table 2. All property values, with the exception of Apparent Opening Size (AOS), represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

Both woven and nonwoven geotextiles are acceptable; however, woven “slit-film” geotextiles will not be allowed and woven geotextiles will not be allowed for subgrade stabilization/reinforcement under pavement structural sections. (See Table on next page.)

**TABLE 2 - STABILIZATION/REINFORCEMENT GEOTEXTILE PROPERTY VALUES**

Other Properties	Test Method	Requirements
Geotextile class		Class 1 from Table 1 <sup>a</sup>
Permittivity (minimum)	ASTM D4491	0.05/sec <sup>b</sup>
Apparent Opening Size (AOS)	ASTM D4751	0.43mm (maximum)
Ultraviolet Stability (Retained Strength)	ASTM D4355	50% after 500 hours of exposure
<sup>a</sup>	Default geotextile selection. Class 2 or 3 may be specified based on survivability or field testing.	
<sup>b</sup>	Permittivity 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.	

722.02 **Drainage Geotextile** - The Drainage Geotextile shall meet or exceed the requirements of Table 3. All property values, with the exception of AOS, represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

Both woven and nonwoven geotextiles are acceptable, however, woven "slit-film" geotextiles will not be allowed.

**TABLE 3 - DRAINAGE GEOTEXTILE PROPERTY VALUES**

Other Properties	Test Method	Requirements		
		Percent In-Situ Soil Passing #200 (0.075 mm) <sup>a</sup>		
		<15%	15% to 50%	>50%
Geotextile class		Class 2 from Table 1b		
Permittivity <sup>c, d</sup> (minimum)	ASTM D4491	0.5/sec	0.2/sec	0.1/sec
Apparent Opening Size (AOS) mm (maximum) <sup>c, d</sup>	ASTM D4751	0.43	0.25	0.22 <sup>e</sup>
Ultraviolet Stability (Retained Strength)	ASTM D4355	50% after 500 hours of exposure		
<sup>a</sup>	Based on grain size analysis of in situ soil in accordance with AASHTO T 88.			
<sup>b</sup>	Default geotextile selection. Class 3 may be specified based on survivability, field testing or specific drain construction requirements.			
<sup>c</sup>	These default filtration property values are based on predominant particle sizes of the in-situ soils. In addition to the default permittivity value, the Resident may require geotextile permeability and/or performance testing based on engineering design for drainage systems in problematic soil environments.			
<sup>d</sup>	Site specific geotextile design should be performed especially if one or more of the following problematic soil environments are encountered: unstable or highly erodible soils such as non-cohesive silts; gap graded soils; alternating sand/silt laminated soils; dispersive clays; and/or rock flour.			
<sup>e</sup>	For cohesive soils with a plasticity index greater than 7, geotextile maximum average roll value for apparent opening size is 0.30mm.			

722.03 **Erosion Control Geotextile** - The Erosion Control geotextile shall meet or exceed the requirements of Table 4. All property values, with the exception of AOS, represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

Both woven and non-woven geotextiles are acceptable; however, woven “slit-film” geotextiles will not be allowed.

**TABLE 4 – EROSION CONTROL GEOTEXTILE PROPERTY VALUES**

Other Properties	Test Method	Requirements Percent In-Situ Soil Passing #200 (0.075 mm) <sup>a</sup>		
		<15%	15% to 50%	>50%
Geotextile class: Woven monofilament geotextiles All other geotextiles		Class 2 from Table 1 (see below) Class 1 from Table 1 (see below)		
Permittivity <sup>a, b</sup> (minimum)	ASTM D4491	0.7/sec	0.2/sec	0.1/sec
Apparent Opening Size (AOS) mm (maximum) <sup>b, c, d</sup>	ASTM D4751	0.43	0.25	0.22 <sup>c, d</sup>
Ultraviolet Stability (Retained Strength)	ASTM D4355	50% after 500 hours of exposure		
<sup>a</sup>	Based on grain size analysis of in situ soil in accordance with AASHTO T 88.			
<sup>b</sup>	These default filtration property values are based on predominant particle sizes of the in-situ soils. In addition to the default permittivity value, the Resident may require geotextile permeability and/or performance testing based on engineering design for drainage systems in problematic soil environments.			
<sup>c</sup>	Site specific geotextile design should be performed especially if one or more of the following problematic soil environments are encountered: unstable or highly erodible soils such as non-cohesive silts; gap graded soils; alternating sand/silt laminated soils; dispersive clays; and/or rock flour.			
<sup>d</sup>	For cohesive soils with a plasticity index greater than 7, geotextile maximum average roll value for apparent opening size is 0.30mm. 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 220 lb, stone drop height is less than 3 ft, and no aggregate bedding layer is required.
- b. Armor layer stone weighs more than 220 lb, stone drop height is less than 3 ft, and the geotextile is protected by a 6" 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 220 lb, stone drop height is less than 3 ft, and the geotextile is protected by a 6" thick aggregate bedding layer designed to be compatible with the armor layer.
- d. Armor layer stone weights do not exceed 220 lb and stone is placed with a zero drop height.

Note: Section 703.25 - Stone Fill has stones up to 500 lb, Section 703.26 - Plain and Hand Laid Riprap has stones up to 200 lb, Section 703.27 - Stone Blanket has stones up to 3,000 lb, Section 703.28 - Heavy Riprap has stones up to 1000 lb.

722.04 **Separation Geotextile** - The Separation geotextile shall meet or exceed the requirements of Tables 5 and 6. All property values, with the exception of AOS, represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values. (See Table 6 on next page.)

Both woven and non-woven geotextiles are acceptable.

**TABLE 5 - SEPARATION GEOTEXTILE PROPERTY VALUES**

Other Properties	Test Method	Requirements
Geotextile class		See Table 6
Permittivity	ASTM D4491	0.02/sec <sup>a</sup>
Apparent Opening Size (AOS)	ASTM D4751	0.60 mm(maximum)
Ultraviolet Stability (Retained Strength)	ASTM D4355	50% after 500 hours of exposure
<sup>a</sup>	Permittivity 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.	

**TABLE 6 - REQUIRED DEGREE OF SURVIVABILITY AS FUNCTION OF SUBGRADE CONDITIONS, CONSTRUCTION EQUIPMENT, AND LIFT THICKNESS**

Required Degree of Survivability as Function of Subgrade Conditions, Construction Equipment, and Lift Thickness <sup>a</sup>	Low Ground-Pressure Equipment ≤3.6 psi	Medium Ground-Pressure Equipment >3.6 to ≤7.3 psi	High Ground-Pressure Equipment >7.3 psi
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 18" in depth or height. All larger depressions are filled. Alternately, a smooth working table may be placed.	Low (Class 3)	Moderate (Class 2)	High (Class 1)
Subgrade has been cleared of obstacles larger than small to moderate -sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 18" in depth or height. Larger depressions should be filled.	Moderate (Class 2)	High (Class 1)	Very High (Class 1+)
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to Project not more than 6" above subgrade. Geotextile may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the geotextile and covering material over them will distort the finished roads surface.	High (Class 1)	Very High (Class 1+)	Not Recommended
<sup>a</sup> Recommendations are for 6 to 12" initial lift thickness. For other initial lift thicknesses: <ul style="list-style-type: none"> <li>• 12 to 18": reduce survivability requirement one level;</li> <li>• 18 to 24": reduce survivability requirement two levels;</li> <li>• &gt;24": reduce survivability requirement three levels.</li> </ul>			

For special construction techniques such as prerutting, increase the geotextile survivability requirement one level. Placement of excessive initial cover material thickness may cause bearing failure of the soft subgrade.

Class 1+ (extra high strength) geotextile properties are higher than Class 1 and shall meet the minimum requirements of Table 7.

**TABLE 7 - CLASS 1+ GEOTEXTILE STRENGTH PROPERTY REQUIREMENTS**

<b>Class 1+ - Extra High Strength Geotextile</b>	<b>Test Method</b>	<b>Class 1+</b>
Grab Strength - lb	ASTM D4632	375
Sewn Seam Strength <sup>a</sup> - lb	ASTM D4632	335
Tear Strength - lb	ASTM D4533	135
Puncture Strength - lb	ASTM D6241	745
<sup>a</sup> When sewn seams are required		