

CATEGORY 900 MATERIALS

900.01 GENERAL. All materials included in this Category will be sampled, tested and inspected as specified in the most recently published cited standards. The specification limits for each material are established and no deviation from these limits will be permitted except when, in the judgment of the Engineer, the deviation will not be detrimental to the work. In such cases, refer to the appropriate specification governing price adjustments for non-conformance.

Within 30 days after receipt of notification of award of the Contract, the Contractor shall submit in writing, to the Engineer, the sources from which the Contractor proposes to obtain all materials to be incorporated into the project. No material shall be introduced into the work until approval of sources has been obtained. The Administration reserves the right to completely or partially test any material for specification compliance.

Sampling shall conform to the Administration's MSMT Field Procedures Manual unless otherwise directed by the Engineer. All source approvals are made subject to continuing production of materials conforming to these Specifications. Material sources may be rejected where it is evident that the material tends to be of marginal quality when compared to the specification limits in any of its specified properties.

SECTION 901 - AGGREGATES

901.01 This section covers the material details, quality requirements and test methods applicable to aggregates. Grading requirements are outlined in Tables 901 A and 901 C; Physical properties in 901 B and 901 D. Force drying may be used in the preparation of samples for grading tests conducted in the field.

TABLE 901 A

AGGREGATE GRADING REQUIREMENTS

MATERIAL	2½"	2"	SIEVE SIZE				
			1½"	1"	¾"	½"	
BANK RUN GRAVEL-SUBBASE-	100	—	—	90-100	—	60-100	
GRADED AGGREGATE-BASE DESIGN RANGE (a)	—	100	95-100	—	70-92	—	
TOLERANCE (b)	—	- 2	± 5	—	± 8	—	
BANK RUN GRAVEL-BASE	100	—	—	85-100	—	60-100	
COARSE AGGREGATE-PORTLAND CEMENT CONCRETE	57 and UNDERDRAIN	—	—	100	95-100	—	25-60
	67	—	—	—	100	90-100	—
	7	—	—	—	—	100	90-100
FINE AGGREGATE- PORTLAND CEMENT CONCRETE and UNDERDRAIN (d)	—	—	—	—	—	—	
COARSE AGGREGATE-LIGHTWEIGHT PORTLAND CEMENT CONCRETE	—	—	—	100	90-100	—	
FINE AGGREGATE - LIGHTWEIGHT PORTLAND CEMENT CONCRETE (d)	—	—	—	—	—	—	
FINE AGGREGATE/ SAND MORTAR and EPOXIES (d)	—	—	—	—	—	—	
MINERAL FILLER	—	—	—	—	—	—	
CRUSHED GLASS (e)	—	—	—	—	100	—	

(a) To establish target values for design.

(b) Production tolerance.

(c) ± 2 for field grading. (omitting T 11)

(d) Fine aggregate includes natural or manufactured sand.

(e) Crushed glass shall not contain more than one percent contaminants by weight.

(f) Reserved

(g) 3" Screen

(h) Graded Aggregate Base shall conform to ASTM D2940. Unless otherwise specified, the gradation design range shall control and the limit for material finer than the 0.02mm is waived.

(i) 8.0 max.

TEST METHOD T 27

SIEVE SIZE									
3/8"	No. 4	No. 8	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
—	—	—	35-90	—	—	20-55	—	—	5-25
50-70	35-55	—	—	—	12-25	—	—	—	0-8 (i)
± 8	± 8	—	—	—	± 5	—	—	—	±3 (c)
—	—	—	35-75	—	—	20-50	—	—	3-20
—	0-10	0-5	—	—	—	—	—	—	—
20-55	0-10	0-5	—	—	—	—	—	—	—
40-70	0-15	0-5	—	—	—	—	—	—	—
100	95-100	—	—	45-80	—	—	10-30	2-10	—
10-50	0-15	—	—	—	—	—	—	—	—
100	85-100	—	—	40-80	—	—	10-35	5-25	—
—	100	95-100	—	—	—	—	—	0-25	0-10
—	—	—	—	—	100	—	95-100	—	70-100
—	0-55	—	—	—	—	—	—	—	—

TABLE 901 B

AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

M A T E R I A L	TEST METHOD			
	S P E C I F I C A T I O N	T 90	T 104	T 112
		PI	SODIUM SULFATE SOUNDNESS	CLAY LUMPS and FRIABLE PARTICLES
		max	% max	% max
BANK RUN GRAVEL- SUBBASE	D 2940	9	12	-
GRADED AGGREGATE- BASE	D 2940	4	12	-
BANK RUN GRAVEL- BASE	D 2940	9	12	-
COARSE AGGREGATE- PORTLAND CEMENT CONCRETE (b)	M 80 CLASS A	-	12	2.0
FINE AGGREGATE- PORTLAND CEMENT CONCRETE (b)(d)	M 6 CLASS B	-	10	3.0
COARSE AGGREGATE- LIGHTWEIGHT PORTLAND CEMENT CONCRETE	M 195	-	-	2.0
FINE AGGREGATE- LIGHTWEIGHT PORTLAND CEMENT CONCRETE (f)	M 195	-	-	2.0
FINE AGGREGATE/SAND MORTAR & EPOXIES	M 45	-	10	1.0
MINERAL FILLER (g)	M 17	NP	-	-
Crushed Glass	M 80	-	12	-
CR-1 (h)		6	12	-
CR-6 (h)		6	12	-
No. 2 (h)		-	12	-
No. 2A (h)		-	12	-

(a) Dimensional ratio of calipers shall be 5:1.

(b) Coarse and fine aggregate for PCC shall be tested for alkali-silica reactivity (ASR) as specified in MSMT 212.

(c) 1.5 if material passing No. 200 sieve is dust of fracture, free of clay or shale.

(d) In areas exposed to traffic manufactured sand, natural sand, or a blend of both shall be used. The sand shall have a minimum ultimate polish value of 8.5.

(e) 5.0 for concrete not subject to surface abrasion.

TEST METHOD					
T 112 & T 113	T 11	T 113	D 4791 (a)	T 96	T 21
SUM OF CLAY LUMPS, FRIABLE PARTICLES and CHERT	MATERIAL FINER THAN No. 200 SIEVE	COAL and LIGNITE	FLAT and ELONGATED	LOS ANGELES ABRASION	ORGANIC IMPURITIES
% max	% max	% max	% max	% max	max
-	-	-	-	50	-
-	-	-	15	50	-
-	-	-	-	50	-
3.0	1.0 (c)	0.5	12	50	-
-	4.0 (e)	1.0	-	-	3
-	-	-	12	-	-
-	-	-	-	-	3
-	-	0.5	-	-	3
-	-	-	-	-	-
-	-	-	-	45	-
-	-	-	15	50	-
-	-	-	15	50	-
-	-	-	15	50	-
-	-	-	15	50	-

(f) Fine aggregate conforming to M 6 may be used if the lightweight concrete does not exceed the maximum unit weight specified in the Contract Documents.

(g) Fly ash shall have a maximum of 12 percent loss on ignition.

h) Other approved inert materials of similar characteristics may be used provided they conform to these provisions. When crushed reclaimed concrete is used, the soundness loss by five cycles of the magnesium sulfate test shall not exceed 18 percent when tested as specified in T 104.

TABLE 901 C

ASPHALT MIXES AGGREGATE GRADING REQUIREMENTS, %

MATERIAL		SIEVE SIZE				
		2"	1½"	1"	¾"	½"
HOT MIX ASPHALT SURFACE - COARSE (SC), (SC Types A & B)		-	-	-	100	86-99
HOT MIX ASPHALT SURFACE - FINE (SF) (b)		-	-	-	-	100
HOT MIX ASPHALT BASE - COARSE (BC)		100	95-100	-	60- 90	-
HOT MIX ASPHALT BASE - FINE (BF)		-	-	100	85- 98	-
OPEN GRADED FRICTION COURSE (OGFC)		-	-	-	-	100
SURFACE REHABILITATION (SR)		-	-	-	-	-
SLURRY SEAL (SS) AND LATEX MODIFIED SLURRY SEAL (LMSS)	MIX II	-	-	-	-	-
	MIX III	-	-	-	-	-
CHIP SEAL SURFACE TREATMENT	7	-	-	-	100	90-100
	8	-	-	-	-	100

(a) T 11 not required.

(b) Also used as curb mix.

PASSING FOR DESIGN MIX, TEST METHOD T 27

SIEVE SIZE							
3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No.100	No.200
70-94	35-68	24-52	16-36	10-26	7-18	4-13	2-9
75-98	47-72	34-56	20-40	14-30	9-20	4-14	1-9
35-55	15-40	10-29	7-21	-	4-11	-	2-6
50-75	30-55	18-40	12-29	-	6-16	-	2-9
90-100	30-50	5-15	4-12	-	-	-	2.0-5.0 (a)
100	80-100	48-74	25-54	16-40	10-28	7-20	5-15 (a)
100	90-100	65-90	45-70	30-50	18-30	10-21	5-15
100	70-95	45-70	28-50	19-34	12-25	7-18	5-15
40-70	0-15	0-5	-	-	-	-	-
85-100	10-30	0-10	0-5	-	-	-	-

TABLE 901 D

AGGREGATE PHYSICAL PROPERTY REQUIREMENTS FOR ASPHALT MIXES

M A T E R I A L	TEST METHOD				
	S P E C I F I C A T I O N	T 90	T 104	T 112	T 113
		PI	SODIUM SULFATE SOUNDNESS	CLAY LUMPS and FRIABLE PARTICLES	CHERT; LESS THAN 2.40 Sp Gr
		max	% max	% max	% max
HOT MIX ASPHALT SURFACE- COARSE (SC)	M 80 CLASS A	NP	12	2.0	3.0
HOT MIX ASPHALT SURFACE- COARSE (SC) TYPES A & B	M 80 CLASS A	NP	12	2.0	3.0
HOT MIX ASPHALT SURFACE- FINE (SF) (c)	M 80 CLASS A	NP	12	2.0	3.0
HOT MIX ASPHALT BASE- FINE (BF) & BASE- COARSE (BC)	M 80 CLASS A	NP	12	2.0	3.0
OPEN GRADED FRICTION COURSE (OGFC) (d)	M 80 CLASS A	NP	12	2.0	3.0
SURFACE REHABILITATION (SR)	-	NP	12	-	-
SLURRY SEAL (SS) & LATEX MODIFIED SLURRY SEAL (LMSS)	-	NP	12	-	-
CHIP SEAL SURFACE TREATMENT	M 80 CLASS A			2.0	3.0
CRUSHED GLASS	M 80	-	12	-	-

(a) Dimensional ratio of calipers shall be 5:1

(b) 4.0 when aggregate from no more than two different sources are blended. Proportions of blended aggregate will be determined as specified in MSMT 416. Not applicable to SC Types A or B and OGFC.

(c) Gravel, if used, shall be crushed. Uncrushed gravel may only be used in base mixes when SF is specified as the surface mix. Crushed gravel shall have a minimum of two fractured faces on at least 75 percent of the material and one fractured face on at least 90 percent of the material.

(d) 1.5 if material passing No. 200 sieve is dust of fracture

(e) Gravel shall not be used in OGFC, SC, and SC Types A & B.

TEST METHOD						
T 112 & T 113	T 11	T 113	D 4791 (a)	T 96	MSMT 411	
SUM OF CLAY LUMPS, FRIABLE PARTICLES and CHERT	MATERIAL FINER THAN No. 200 SIEVE	COAL and LIGNITE	FLAT and ELONGATED	LOS ANGELES ABRASION	PV	LCF
% max	% max	% max	% max	% max	min	million min
3.0	-	0.5	12	45	3.5 (b)	15
3.0	-	0.5	12	45	8.5	20
3.0	-	0.5	12	45	3.5 (b)	-
3.0	-	0.5	12	45	-	-
3.0	-	0.5	-	45	8.5	20
-	-	-	-	-	3.5	-
-	-	-	-	-	3.5	-
3.0	1.0 (d)	0.5	-	45	-	-
-	-	-	-	45	-	-

901.02 STONE FOR RIPRAP, CHANNELS, DITCHES, SLOPES AND GABIONS. The stone shall be field or quarry stone of approved quality and may be certified from a source previously approved. Maximum dimension shall not exceed four times the minimum dimension.

901.02.01 Stone for Riprap. Stone for riprap shall be uniformly graded from the smallest to the largest pieces as specified in the Contract Documents. The stone will be accepted upon visual inspection at the point of usage, and shall conform to the following:

CLASS OF RIPRAP	WEIGHT RANGES lb (kg)	APPROX. SIZE in. (mm)
0	1-33 (0.5-15)	2-7 (50-175)
I	2-150 (1-70)	3-12 (75-300)
II	20-700 (10-320)	6-20 (150-500)
III	40-2000 (20-910)	8-28 (200-700)

901.03 STONE FOR CHANNELS AND DITCHES. Stone for channels and ditches shall conform to the size requirements of Class I Riprap and the following:

QUALITY REQUIREMENTS	
TEST AND METHOD	SPECIFICATION LIMITS
Apparent Specific Gravity T 85, min	2.50
Absorption T 85, % max	3.0
Sodium Sulphate Soundness 5 cycles, 2½ - 1½ in. (63-37.5 mm) Aggregate T 104, % loss max	20

901.04 STONE FOR SLOPES. Stone for slopes shall conform to M 43,

size number 1 omitting T 11. The stone shall also conform to the quality requirements specified in 901.03.

901.05 STONE FOR GABIONS. Stone for gabions shall conform to the quality requirements specified in 901.03 and the following, except that the loss by sodium sulfate shall not be greater than 12 percent.

Error! Bookmark not defined. DEPTH OF BASKET in. (mm)	SIZE OF INDIVIDUAL PIECES in. (mm)
6 (150)	3 - 6 (75 - 150)
9 (225)	4 - 7 (100 - 175)
12 (300)	4 - 7 (100 - 175)
18 (460)	4 - 7 (100 - 175)
36 (910)	4 - 12 (100 - 300)

Size of pieces will be determined visually.

SECTION 902 - PORTLAND CEMENT CONCRETE AND RELATED PRODUCTS

902.01 STORAGE. Storage of materials shall conform to the Contract Documents and as directed by the Engineer.

902.02 CERTIFICATION OF PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENT. The manufacturer shall furnish certification as specified in TC-1.02. The certification shall also include:

- (a) The mill shall report its quality control procedures, and submit a new report whenever there is a procedural change.
- (b) The mill's control laboratory shall be inspected by the Cement and

Concrete Reference Laboratory of the National Institute of Standards and Technology on their regularly scheduled visits. The Engineer shall be provided with copies of the reports of these inspections along with an account of the action taken to correct cited deficiencies.

- (c) Records of data accumulated by the quality control procedures shall be produced upon request.
- (d) A certified document shall accompany each shipment stating that the contents meet all applicable requirements. Additionally, the document shall show the producer's name, mill location, carrier number, date loaded, weight contained in carrier, silo number, consignee, destination, contract number and type of cement. The signature and title of the signer shall be shown on the document.
- (e) The mill shall, upon request, supply certified chemical and physical test values that can be associated with any sample representing cement drawn from a particular silo on a given date.
- (f) Acceptance of cement by certification will be terminated if test results differ from mill results by more than the precision limits given in the test method. The acceptance procedure shall then revert to storage testing and approval prior to shipment.

902.03 PORTLAND CEMENT. Portland cement shall conform to M 85, with the fineness and the time of setting determined in conformance with T 153 and T 131 respectively.

902.04 BLENDED HYDRAULIC CEMENT. Blended hydraulic cement shall conform to M 240, Type I (PM), except that the maximum loss on ignition shall be 3.0 percent and ground iron blast furnace slag shall not be used for blending.

902.05 MASONRY CEMENT. Masonry cement shall conform to C 91, except the water retention and staining tests are waived.

902.06 CONCRETE ADMIXTURES. Concrete admixtures shall not contribute more than 200 ppm of chlorides based on the cement content when tested as specified in MSMT 610. Only prequalified admixtures shall be used.

A pozzolan and Type I (PM) cement shall not be used in the same mix. Since the strength gains are delayed with these materials, a longer period of time may be required for curing and form removal.

902.06.01 Air Entraining Admixtures. Air entraining admixtures shall conform to M 154.

902.06.02 Chemical Admixtures. Chemical admixtures shall conform to M 194, Type A, Type D, or nonchloride Type C.

902.06.03 High Range Water Reducing Admixtures. High range water reducing admixtures shall be liquid and shall conform to M 194, except that the water content shall be a maximum of 85 percent of that of the control, and the durability factor shall be a minimum of 90. Type F shall be used for early strength and shall produce a minimum compressive strength in 12 hours of 180 percent of that of the control. Type G shall be used when early strength is not specified. The manufacturer shall furnish certification as specified in TC-1.02. The certification shall include curves indicating the fluid ounces of admixture per 100 lb (45 kg) of cement as related to water reduction and strength gain for 12 hours when used with a cement factor of 700 lb (317 kg) minimum.

902.06.04 Pozzolans. The Contractor may request the use of pozzolans to control alkali silica reactivity or for other reasons. When a pozzolan is used, the minimum cement factor and water/cement ratio shall be determined on the basis of the combined weight of cement and pozzolan.

- (a) **Fly Ash.** Fly ash shall conform to M 295, pozzolan Class C or F, except that the maximum permissible moisture content shall be 1.0 percent, and when used in concrete Mix Nos.3 and 6 the loss on ignition shall not exceed 3.0 percent.

(b) **Ground Iron Blast Furnace Slag.** Ground iron blast furnace slag shall conform to M 302, Grade 120.

(c) **Microsilica.** Microsilica shall conform to M 307.

NOTE: See Table 902 B for percentage of microsilica and fly ash.

902.06.05 Ground Iron Blast Furnace Slag. The Contractor may request to substitute a maximum of 50 percent of the weight of cement with ground iron blast furnace slag. When ground iron blast furnace slag is used, the minimum cement factor and water cement ratio will be determined on the basis of the combined weight of the cement and ground iron blast furnace slag. Ground iron blast furnace slag shall conform to M 302, Grade 120.

902.06.06 Synthetic Fibers. When synthetic fibers are specified in the Contract Documents, the fibers shall be 1/2 to 1½ in. (13-38 mm) long and conform to C 1116, Type III. The manufacturer shall furnish certification as specified in TC-1.02. The quantity of fibers used and their point of introduction into the mix shall conform to the fiber manufacturer's recommendations.

902.07 PORTLAND CEMENT CONCRETE CURING MATERIALS. Curing materials shall be burlap cloth, sheet materials, liquid membrane forming compounds or cotton mats.

902.07.01 Burlap. Burlap cloth shall be made from jute or kenaf and conform to M 182, Class 1, 2 or 3.

902.07.02 Sheet Materials. Sheet material shall conform to M 171 with the following exceptions:

(a) **White Opaque Burlap Polyethylene (PE) Sheeting.** Tensile strength and elongation requirements are waived. The sheeting shall have a finished product weight of not less than 10 oz/yd² (340 g/m²).

(b) **White Opaque Polyethylene (PE) Backed Nonwoven Fabric.** The material shall conform to 902.07.02(a), with the thickness requirement waived. The finished product weight shall not be less than 5 oz/yd² (170 g/m²).

(c) **White Opaque Polyethylene (PE) Film.** Tensile strength and elongation requirements are waived.

902.07.03 Liquid Membrane. Liquid membrane forming compounds shall conform to M 148.

Field control testing of the white pigmented curing compounds shall be on the basis of weight per gallon (liter). The samples shall not deviate more than ± 0.3 lb/gal (40 g/l) from the original source sample.

902.07.04 Cotton Mats. Cotton mats shall consist of a filling material of cotton bats or bats covered with unsized cloth and tufted or stitched to maintain the shape and stability of the unit under job conditions of handling.

The covering shall be either cotton cloth, burlap or jute having the following properties:

- (a) Cotton cloth covering shall weigh not less than 6.0 oz/yd² (200 g/m²) and shall have an average of not less than 32 threads/in. (25 mm) of warp and not less than 28 threads/in. (25 mm) of filling. The raw material used in the manufacture of the cotton cloth shall be raw cotton, cotton comber waste, cotton card strip waste, or combinations thereof.

- (b) Burlap or jute covering for cotton mats shall weigh not less than 6.4 oz/yd² (220 g/m²) and shall have not less than 8 threads/in. (25 mm) of warp and not less than 8 threads/in. (25 mm) of filling. It shall be the grade known commercially as “firsts” and shall be free from avoidable imperfections in manufacture and from defects or blemishes affecting the serviceability.

The filling material for the mats shall be a cotton bat, or bats made of raw cotton, cotton waste, cotton linters, or combinations thereof, and shall weigh not less than 12 oz/yd² (410 g/m²).

902.08 FORM RELEASE COMPOUNDS. Form release compounds shall effectively prevent the bond of the concrete to the forms. The form release compounds shall not cause discoloration of the concrete nor adversely affect the quality or rate of hardening at the interface of the forms.

The flash point of the form release compound shall be a minimum of 100 F (38 C) when tested as specified in T 73.

902.09 PARAFFIN WAX. Paraffin wax for use as a bond breaker for concrete shall be clear. The flash point shall not be less than 380 F (193 C) when tested as specified in D 92.

902.10 PORTLAND CEMENT CONCRETE. Portland cement concrete shall conform to the applicable portions of Section 915 and the following:

902.10.01 Proportioning. Prior to the start of construction, the Contractor shall submit to the Regional Engineer the source and proportions of materials to be used for each concrete mix. The mixture shall conform to 902.10.03.

The concrete, with the exception of water and chemical admixtures, shall be proportioned by weight. Water and chemical admixtures may be proportioned by volume or weight. The mix shall be uniform and workable.

902.10.02 Materials.

Coarse Aggregate	901
Fine Aggregate	901
Cement	902.03 and 902.04
Concrete Admixtures	902.06
Water	921.01

902.10.03 Portland Cement Concrete Mixtures. The concrete mixes shall conform to the following:

TABLE 902 A

PORTLAND CEMENT CONCRETE MIXTURES				
MIX NO.	28 DAY SPECIFIED COMPRESSIVE STRENGTH	STANDARD DEVIATION	CRITICAL VALUE	MIN CEMENT FACTOR
	psi (MPa)	psi (MPa)	psi (MPa)	lb/yd³ (kg/m³)
1	2500 (17.2)	375 (2.6)	2430 (16.8)	455 (270)
2	3000 (20.7)	450 (3.1)	3010 (20.8)	530 (315)
3	3500 (24.1)	525 (3.6)	3600 (24.8)	580 (345)
4	3500 (24.1)	525 (3.6)	3600 (24.8)	615 (365)
5	3500 (24.1)	525 (3.6)	3600 (24.8)	580 (345)
6	4500 (31.0)	675 (4.7)	4770 (32.9)	615 (365)
7	350 (2.4) split tensile	-	-	580 (345)

- NOTE 1: When concrete is exposed to water exceeding 15 000 ppm sodium chloride content, Type II cement shall be used.
- NOTE 2: The temperature of Mix No. 6 when used for other than superstructure work as defined in TC-1.02 shall be 70 ±20 F (21 ±11 C).
- NOTE 3: When synthetic fibers are used, the slump shall not exceed 5 in. (125 mm).
- NOTE 4: Nonchloride Type C admixtures may be used when approved by the Engineer.

PORTLAND CEMENT CONCRETE MIXTURES				
COARSE AGGREGATE SIZE	MAX WATER/ CEMENT RATIO	SLUMP RANGE	TOTAL AIR CONTENT	CONCRETE TEMPERATURE
M 43	by wt	in. (mm)	%	F (C)
57, 67	0.55	2-5 (50-125)	5-8	70 ± 20 (21 ± 11)
57, 67	0.50	2-5 (50-125)	5-8	70 ± 20 (21 ± 11)
57, 67	0.50	2-5 (50-125)	5-8	70 ± 20 (21 ± 11)
57, 67	0.55	4-8 (100-200)	N/A	70 ± 20 (21 ± 11)
7	0.50	2-5 (50-125)	5-8	70 ± 20 (21 ± 11)
57, 67	0.45	2-5 (50-125)	5-8	65 ± 15 (18 ± 8)
57	0.50	1½ -3 (40-75), 2½ max if slip-formed	5-8	70 ± 20 (21 ± 11)

Coarse and fine aggregate tested for alkali silica reactivity (ASR) as specified in MSMT 212 having an expansion <0.10 percent may be used without restriction. Those having an expansion >0.35 percent shall not be used. Aggregates having an expansion >0.10 but <0.35 percent shall be considered reactive and shall only be used when one of the following options is employed:

TABLE 902 B

OPTION	ALKALI CONTENT OF CEMENT % max	REPLACE CEMENT WITH		SPECIFICATION
		MATERIAL	% BY WEIGHT	
1	1.50	Class F Fly Ash	15-25	M 295
2	1.50	Ground Iron Blast Furnace Slag	25-50	M 302 Grade 120
3	1.50	Microsilica	5-10	M 307
4	-	Blended Cement*	100	M 240
5	0.60	Low Alkali Cement	100	M 85

* Pozzolan content of 15-25 percent by weight of cement.

When reactive aggregate is used, the Contractor shall designate which option he will use to control the formation of the ASR gel. If an option other than option 5 in the Table above is chosen, the Contractor shall conduct tests as specified in MSMT 212 using the reactive aggregate and the proposed cementitious material. For approval, the expansion test results shall not be >0.10 percent. When more than one reactive aggregate is used in a concrete mix, each shall be tested individually and the maximum amount of pozzolan required to reduce the expansion of all the aggregates to <0.10 percent shall be used. The Contractor shall submit to the Engineer the aggregate source, test results, and the percent and type of replacement cement. The Engineer may withhold source approval pending verification testing.

902.10.04 Trial Batch. A trial batch will be prepared to certify that each mix conforms to 902.10.05 and 902.10.06. Approval will be given when the test results conform to the minimum required average strength.

The Contractor shall make arrangements with the Regional Engineer, at least two weeks in advance, to have an authorized representative present during the batching and testing. Each trial batch shall consist of at least 3 yd³ (2 m³) of concrete. All materials, equipment, and labor required to produce the trial batches and conduct the required tests shall be supplied by and at the Contractor's expense.

The requirement for a trial batch may be waived by the Regional Engineer when past performance records show that the required average strength requirement has been met.

Mix No. 7 may be approved from laboratory testing in lieu of field trial batching. The testing shall be at the Contractor's expense.

902.10.05 Design Required Average Strength. The required average strength (f_{cr}') shall be the larger of:

$$f_{cr}' = f_{c'} + (1.34 \times S)$$

or

$$f_{cr}' = f_{c'} + (2.33 \times S) - 500$$

where:

f_c' = the 28 day specified compressive strength

S = the standard deviation as specified in 902.10.06.

A test is defined as the average strength of two companion cylinders.

902.10.06 Standard Deviation.

- (a) When past performance records are available, a standard deviation shall be established from documented performance records of the producer consisting of a minimum of 15 consecutive 28 day compressive strength tests obtained within the last 12 months. The standard deviation shall be established as the product of the calculated standard deviation and multiplier.

NUMBER OF TESTS	MULTIPLIER FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

Interpolate for intermediate number of tests.

- (b) When past performance records are not available, the required average strength shall conform to the following:

SPECIFIED COMPRESSIVE STRENGTH f_c', psi (Mpa)	REQUIRED AVERAGE COMPRESSIVE STRENGTH f_{cr}', psi (MPa)
Less than 3000 (20.7)	$f_c' + 750$ (5.2)
3000 - 4000 (20.7 - 27.6)	$f_c' + 1000$ (6.9)
4001 - 5000 (27.6 - 34.5)	$f_c' + 1200$ (8.3)
over 5000 (34.5)	$f_c' + 1400$ (9.6)

902.10.07 Standard of Control. The average of all sets of three consecutive strength tests shall equal or exceed the critical value as specified in 902.10.03 which shall be computed using the following formula:

$$\text{Critical Value} = f_c' + (1.14 \times S) - 500 \text{ (3.4 MPa)}$$

Failure to conform to these criteria shall be cause for immediate investigation and remedial action up to and including suspension of production. A design standard deviation equal to 15 percent of the specified strength shall be used for calculation until a minimum of 15 test results are obtained.

The actual average strength and standard deviation shall be computed upon the availability of 28 day strength data comprising a minimum of 15 tests. Should this determination indicate an excessive margin of safety, the concrete mix may be modified to produce lower average strength as approved by the Engineer. If these calculations indicate a coefficient of variation greater than 15, the quality of the concrete and testing will be evaluated.

902.10.08 Testing. Sampling shall conform to T 141. Testing shall be performed as follows:

TEST	METHOD	MINIMUM TEST FREQUENCY	RESPONSIBILITY
Slump	T 119	1 per 50 yd ³ (38.2 m ³) (or fraction thereof)	Contractor
Air Content	T 152 T 196	1 per 50 yd ³ (38.2 m ³) (or fraction thereof)	Contractor
Compression	T 23	1 per 50 yd ³ (38.2 m ³) (or fraction thereof)	Contractor
Split Tensile Mix No. 7 Only	T 23	3 per Day	Contractor

NOTE 1: For plain cement concrete mold three (3) cylinders per test and for reinforced concrete four (4) cylinders per test.

NOTE 2: A second test will be made if the first slump or air content test fails. Acceptance or rejection will be based on the results of the second test.

NOTE 3: Cylinders shall be protected on jobsite for 16 +/- hours and then delivered to the materials testing laboratory designated by the Engineer with written reports of slump and air content tests.

902.10.09 Acceptance. Concrete will be acceptable if both of the following requirements are met:

- (a) The average of all sets of three consecutive strength tests equal or exceed the specified design strength.
- (b) No individual strength test (average of two companion cylinders) falls below the specified design strength by more than 500 psi (3.4 MPa).

902.10.10 Price Adjustment. A price adjustment will be based on the Contract unit price per cubic yard (0.76 cubic meter) of concrete. If the unit is a Lump Sum item, the price per cubic yard (0.76 cubic meter) for the concrete will be determined by dividing the cubic yards (0.76 cubic meter) into the Contract lump sum price.

- (a) **Test Results More Than 500 psi (3.4 MPa) Below The Specified Design Strength.** Failing strength tests will be considered individually with a price adjustment being applied on the percentage basis as shown below. This method of price adjustment will be used for Mix No. 7 having a failure greater than 50 psi (345 kPa).

(Price per yd³) x (quantity of yd³ represented by the failing concrete strength) x (percent of failure).

Example:

$$\$400.00 \text{ per yd}^3 \times 50 \text{ yd}^3 \times [1 - (3600/4500 \text{ psi})] = \$4,000.00$$

No payment will be allowed when the test results fall below 50 percent of the specified design strength for structural concrete or 40 percent for incidental concrete.

The Engineer will determine when the strength of the concrete represented by the failing tests is sufficient to remain in place or whether it must be removed and replaced with specification concrete.

- (b) Test Results 500 psi (3.4 MPa) or less Below The Specified Design Strength.** Strength failures 500 psi (3.4 MPa) or less than the specified design strength will be averaged with the next two consecutive tests. If those two tests include a failure greater than 500 psi (3.4 MPa), those tests will be evaluated as in (a) and replaced with the next consecutive test. If the resulting average falls below the specified design strength, a price adjustment will be applied in conformance with the table below. Any failure will only be included in one grouping.

STRENGTH BELOW THE SPECIFIED (avg of 3 tests) DESIGN LEVEL, psi (kPa)		ADJUSTMENT FACTOR
MIX NO. 1 THRU MIX NO. 6	MIX NO. 7	
1 - 100 (1 - 693)	1 - 10 (1 - 72)	0.005
101 - 200 (694 - 1382)	11 - 20 (73 - 141)	0.01
201 - 300 (1383 - 2072)	21 - 30 (142 - 210)	0.02
301 - 400 (2073 - 2761)	31 - 40 (211 - 279)	0.04
401 - 500 (2762 - 3447)	41 - 50 (280 - 345)	0.08

Adjustment price equals (price per yd³) x (quantity of yd³ represented by the failing cylinders) x (the adjustment factor).

Example:

$$\$400.00 \text{ per yd}^3 \times 50 \text{ yd}^3 \times 0.01 = \$200.00$$

902.11 MORTAR FOR GROUT. Mortar used for grouting anchor bolts, pipe, handrail posts and miscellaneous items shall be composed in conformance with one of the following:

- (a) One part portland cement or blended hydraulic cement and one part mortar sand by dry loose volume.
- (b) Prepared bag mixes consisting of portland cement or blended hydraulic cement and mortar sand. The prepared mixes shall produce a mortar conforming to the strength requirements specified in the Contract Documents.
- (c) Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of 5000 psi (34.5 MPa) in seven days when tested as specified in T 106 except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of 0.0 percent after seven days when tested as specified in T 160.
- (d) Epoxy grout shall consist of sand and epoxy mixed by volume in conformance with the manufacturer's recommendations. The grout shall be capable of developing a minimum compressive strength of 6500 psi (44.8 MPa) in 72 hours when tested as specified in MSMT 501. Sand for epoxy grout shall conform to Section 901, Tables 901 A and 901 B.
- (e) An epoxy or polyester anchoring system may be used when approved by the Engineer in conformance with the manufacturer's recommendations. Strength values shall be as specified in the Contract Documents.

902.12 LINSEED OIL. Linseed oil shall consist of a 50-50 mixture (by volume) of boiled linseed oil conforming to Federal Specification TT-L-190 and kerosene conforming to D 3699.

902.13 LATEX MODIFIED CONCRETE. Portland cement concrete containing prequalified laboratory approved styrene butadiene latex emulsion is defined as Latex Modified Concrete (LMC).

Latex emulsion shall have a minimum of 90 percent of the nonvolatiles as styrene butadiene polymers. The latex emulsion shall conform to Table 902.13 A. The material shall be stored in suitable containers and be protected from freezing and exposure to temperatures in excess of 85 F (29 C).

Latex modified concrete shall be proportioned using volumetric mixing and designed as follows:

LATEX MODIFIED CONCRETE	
MATERIAL	SPECIFICATION LIMITS
Portland Cement, CWT/yd ³ (kg/m ³), min	6.6 (390)
Latex Emulsion/Cement Ratio	0.31 - 0.34
Water/Cement Ratio, max	0.22
Entrained Air, %	6.0 ± 3
Slump, in. (mm)	5 ± 1 (125 ± 25)

The physical properties of LMC shall conform to Table 902.13 B. The Contractor shall also furnish the necessary 3 x 6 in. (75 x 150 mm) molds conforming to M 205 to be used for the fabrication of compressive strength cylinders.

Control and Acceptance Sampling.

- (a) One sample, 2 qt (2 l) minimum, of the styrene butadiene latex emulsion shall be submitted to the Regional Engineer daily for each lot of material used in a day’s production.
- (b) A batch for LMC is defined as the capacity of the equipment being used on the project. Slump and air samples will be taken and tested before the placement of a batch is permitted. The slump shall be

measured four to five minutes after discharge from the mixer. The test material shall be deposited off the deck and not be disturbed during this waiting period. One additional sample for slump and air will be taken randomly during the placement of each batch. For seven day compressive strength, two tests each per batch are required. A test is defined as consisting of two companion cylinders. The samples for these tests will be taken at random while the placement is in progress.

REQUIREMENTS FOR CHEMICAL PROPERTIES OF LATEX EMULSION MATERIALS				
PROPERTY	SPECIFICATIONS		QUALITY ASSURANCE TESTS	
	LIMITS	TOLERANCE	PREQUALI- FICATION TESTS	CONTROL AND ACCEPTANCE
Color	White	-	X	X
pH	9.0 - 11.0	-	X	X
Weight, lb/gal (kg/l)	8.40 - 8.47	-	X	X
Solids Content, %	46 - 53	-	X	X
*Butadiene Content, % of polymer	30 - 40	-	-	-
Viscosity @ 10 rpm-cps	Match Original	± 20	X	X
*Surface Tension, dynes/cm max	50	-	-	-
*Mean Particle Size, polymer - Å	1400 - 2500	-	-	-
Coagulum, % max	0.10	-	X	X
*Freeze-Thaw Stability, coagulum, % max	0.10	-	X	X
Infrared Spectra of Latex Film	Match Original	-	X	X
Infrared of Alcohol, Soluble Portion of Latex	Match Original	-	X	X
Shelf Life, min	1 yr	-	X	-

NOTE 1: Quality Assurance Tests shall be conducted as specified in MSMT 612 except those denoted by * shall be conducted as specified in FHWA RD - 78-35.

NOTE 2: The original or prequalification sample shall be accompanied by the producer's certification on all of the tests and properties noted above and as specified in TC-1.02. The certification shall contain actual test values of the product and the infrared spectrograph.

NOTE 3: A separate certification is required for each lot of material. The document shall note the date of manufacture, lot size and whether or not the material is identical to the formulation of the original sample.

TABLE 902.13 B

LATEX MODIFIED CONCRETE PHYSICAL PROPERTIES			
TEST PROPERTY	TEST VALUES	QUALITY ASSURANCE TESTS	
		PREQUALIFIED TESTS	CONTROL AND ACCEPTANCE
7 Day Compressive Strength, psi (MPa) min	3000 (20.7)	X	X
28 Day Compressive Strength, psi (MPa) min	3500 (24.1)	X	-
42 Day Compressive Strength, psi (MPa) min	3500 (24.1)	X	-
7 Day Flexural Strength, psi (MPa) min	550 (3.8)	X	-
28 Day Flexural Strength, psi (MPa) min	650 (4.5)	X	-
42 Day Shear Bond Strength, psi (MPa) min	2000 (13.8)	X	-
Durability Factor, 300 cycles, % min	85	X	-
Chloride Permeability, ppm max	510	X	-
Scaling Resistance, 50 cycles, max	3	X	-

NOTE 1: Quality Assurance Tests shall be conducted as specified in MSMT 721.

NOTE 2: Seven Day Compressive Strength Test will be used for Control & Acceptance of the material. The strength level of 3000 psi (20.7 MPa) at seven days shall be the minimum specified design strength. The mix design approval and acceptance will be based on a coefficient of variation of 10 percent with a probability of 1 in 10 tests falling below the specified strength. No test value shall fall below 80 percent of the specified strength.

SECTION 903 - MASONRY PRODUCTS

903.01 SEWER BRICK. Sewer brick shall have a standard size of 2 1/4 x 3 3/4 x 8 in. (57 x 95 x 200 mm) and conform to M 91, Grade SM.

903.02 MANHOLE BRICK. Manhole brick shall conform to M 91, Grade SM.

903.03 BUILDING BRICK. Building brick shall conform to M 114, Grade SW.

903.04 HOLLOW CONCRETE MASONRY BLOCK. Hollow load bearing concrete masonry block shall conform to C 90, Grade N, Type I, normal weight.

903.05 SOLID CONCRETE MASONRY BLOCK. Solid concrete masonry block shall conform to C 139.

903.06 MORTAR FOR MASONRY. Mortar used for masonry shall be composed in conformance with one of the following:

- (a) One part portland or blended cement and three parts mortar sand by dry loose volume and hydrated lime not to exceed 20 percent of the cement by weight;
- (b) One part masonry cement and three parts mortar sand by dry loose volume;
- (c) Prepared bag mixes consisting of masonry cement and mortar sand. The prepared mixes shall produce a minimum compressive strength of 500 psi (3.4 MPa) in seven days when tested using the applicable procedures specified in C 91.

Materials for mortar shall conform to the following:

Mortar Sand	901.01
Portland Cement	902.03

Blended Cement	902.04
Masonry Cement	902.05
Water	921.01
Lime	921.03

SECTION 904 - ASPHALT CEMENTS AND HOT MIX ASPHALT

904.01 CERTIFICATION. The manufacturer and hauler shall furnish certifications as specified in TC-1.02 and the following:

The manufacturer shall also certify:

- (a) Date and time of loading.
- (b) Tank or blending system.
- (c) Identification of hauling unit.
- (d) Type, grade, temperature and quantity of materials.
- (e) Complete certified analysis.
- (f) Lot number, if applicable.

The hauler shall also certify:

- (a) Identification of hauling unit.
- (b) Type, grade and source of last delivery.
- (c) The date of the last delivery using this hauling tank and volume of material remaining in the tank at the time of the current loading.

904.02 ASPHALT CEMENTS. Asphalt cements used for mixes containing all virgin materials shall conform to M 226, Table 2, Grade AC-20, except that the requirements for solubility in trichloroethylene and the percent loss on heating are waived. To facilitate placement of OGFC one oz of silicone per 5000 gallons of asphalt cement may be added.

Asphalt cements used for mixes containing recycled asphalt pavement materials shall conform to M 226, Table 2, Grade AC-10 or AC-20, except that the requirements for solubility in trichloroethylene and the percent loss on heating are waived. The viscosity of the asphalt recovered from the final plant mixed material shall not exceed 8000 poises at 140 F (60 C).

Polymer Modified Asphalt. Polymer modified asphalt shall conform to the following:

TEST AND METHOD	SPECIFICATION LIMITS					
	IB	IIB	IIIB	ID	IIC	IID
Ductility, 39.2 F (4.0 C), 5 cpm, cm minimum T 51	-	50	-	-	25	-
Penetration, 77 F (25 C), 100 g, 5 sec, T 49	75-100	70-100	60-100	40-75	40-75	40-75
Penetration, 39.2 F (4.0 C), 200 g, 60 sec min, T 49	30	-	35	25	-	18
Viscosity, 140 F (60 C), P minimum, T 202	2500	1600	-	5000	1600	-
Vis., 275 F (135 C), Cs, T 201	2000 max	2000 max	150-1500	2000 max	2000 max	150-1500
Softening Point, R & B, F (C) minimum, T 53	120 (49)	-	130 (54)	140 (60)	-	140 (60)
Flash Point, F (C), minimum, T 48	425 (219)	450 (232)	425 (219)	450 (232)	450 (232)	425 (219)
Solubil. in TCE, % min., T 44	99.0	99	-	99.0	99	-
Separation, R & B difference, F (C), max (a)(b)	4 (2.2)	-	4 (2.2)	4 (2.2)	-	4 (2.2)
Toughness, 77 F (25 C), 20 ipm (500mm/min), in lb (N m) min	-	110 (12.4)	-	-	110 (12.4)	-
Tenacity, 77 F (25 C), 20 ipm (500 mm/min), in lb (N m) minimum	-	75 (8.5)	-	-	75 (8.5)	-
THIN FILM OVEN TEST (TFOT) RESIDUE						
Elastic Recovery, 77 F (25 C), minimum	45	-	-	50	-	-
Penetration, 39.2 F (4.0 C), 200 g, 60 sec min, T 49	15	-	18	13	-	9
Viscosity, 140 F (60 C), P max, T 202	-	8000	-	-	8000	-
Ductility, 39.2 F (4.0 C), 5 cpm, cm min, T 51	-	25	-	-	8	-
Toughness, 77 F (25 C), 20 ipm (500 mm/min), in lb (N m) min	-	-	-	-	110 (12.4)	-
Tenacity, 77 F (25 C), 20 ipm (500 mm/min), in lb (N m) min	-	-	-	-	75 (8.5)	-
Loss, % max,	-	-	1.0	-	-	1.0

(a) AASHTO - AGC - ARTBA, Task Force 31.

(b) If stored in a tank equipped with continuous mechanical agitation, conditioning of sample is not required. Obtain one sample from the top of storage tank and another from the bottom. Perform R & B on both samples.

904.03 RECYCLING AGENTS. Recycling agents, when specified, shall conform to D 4552.

904.04 CUTBACK ASPHALTS. Cutback asphalts shall conform to M 81 or M 82 except the penetration limits shall be 50 to 120 for M 81 and 90 to 250 for M 82.

904.05 EMULSIFIED ASPHALTS. Emulsified asphalts shall conform to M 140 or M 208 with the following exceptions:

- (a) Cement mixing tests are waived.
- (b) Grade SS-1 viscosity shall be 50 to 400 seconds at 77 F (25 C).
- (c) Maximum of 3.0 percent by volume of oil distillate.
- (d) The sieve test requirement for field samples shall be a maximum of 0.4 percent.

904.06 HOT MIX ASPHALT (HMA). Mixes shall be produced in a plant as specified in Section 915.

904.06.01 Aggregates. Aggregates shall conform to Section 901.

904.06.02 Design Mix. A design mix shall be developed by the Contractor in conformance with T 245, modified by MSMT 405.

The Contractor may elect to use crushed, recycled asphalt pavement (RAP) material. The allowable percentage and its suitability for use shall be determined in conformance with MSMT 412.

Crushed glass shall not be used in surface mixes or open graded friction course (OGFC). RAP shall not be used in OGFC or SC Types A or B.

The following shall be used to determine the target asphalt content:

MIX DESIGNATION	STABILITY	FLOW (b) 0.01 in. (0.3 mm)	VOIDS MINERAL AGGREGATE % min
HOT MIX ASPHALT SURFACE - COARSE (SC) (SC Type A)	1500 (6.6)	8-18	15
(SC Type B)			
HOT MIX ASPHALT SURFACE - FINE (SF)	1000 (4.4)	8-18	15 (f)
HOT MIX ASPHALT BASE - COARSE (BC)	1000 (4.4)	8-18	12
HOT MIX ASPHALT BASE - FINE (BF)	1000 (4.4)	8-18	14
OPEN GRADED FRICTION COURSE (OGFC) (e)	-	-	-
SURFACE REHABILITATION (SR)	1800 (8.0)	-	-

(a) MSMT 405 Marshall Method shall be used where applicable.

(b) The upper limit of the flow requirement will be waived for mixtures using a minimum of 50 percent slag.

(c) MSMT 409 shall be used for OGFC.

(d) May be higher for lightweight or absorptive aggregate.

(e) When RAP is used the asphalt cement binder shall be selected in conformance with MSMT 412.

(f) Delete for curb mix.

(g) 3-8 curb mix.

(h) 25 for curb mix. (In absence of lab design, increase A.C. content of approved paving mix by 1.0%)

VOIDS TOTAL MIX	COMPACTION BLOWS USED	ASPHALT CEMENT	TYPE OF BINDER (e)
%	per face	% by weight	
3-5	75	-	AC 20 ID, IIC or IIID
3-5 (g)	50 (h)	-	AC 20
3-5	50	-	AC 20
3-5	50	-	AC 20
-	-	6.0-9.0 (d)	IB, IIB, or IIIB
1-5	75	5.0-8.0	AC 20

904.06.03 Design Mix Approval. Documents containing the data from the Contractor's laboratory study shall be submitted to the Engineer for approval at least three weeks prior to paving operations, and shall include the following:

- (a) Job mix and plant of origin.
- (b) Cold feed formula.
- (c) Gradation of cold feed aggregates.
- (d) Source and type of asphalt cement and mixing temperature at 220 centistokes.

- (e) Maximum Specific Gravity by test.
- (f) Mix design curves including:
 - (1) Unit weight vs. A.C. Content
 - (2) Stability vs. A.C. Content
 - (3) Flow vs. A.C. Content
 - (4) VMA vs. A.C. Content
 - (5) Voids total vs. A.C. Content
 - (6) 0.45 power gradation curve.

904.06.04 Antistripping Additives. HMA shall have a minimum Tensile Strength Ratio (TSR) of 0.85 when tested as specified in D 4867. The freeze-thaw conditioning cycle is required. When OGFC is used, the specimens shall be fabricated as specified in MSMT 420. HMA mixes not conforming to the minimum TSR requirement and OGFC shall include an antistripping additive.

When an antistripping additive is needed, the exact quantity shall be determined by the producer as specified in D 4867 based on a minimum TSR of 0.85.

When a heat stable antistripping additive is used, the minimum dosage rate shall be 0.20 percent of the total weight of asphalt. The additive shall be introduced at the plant by line blending, metering or otherwise measuring to insure accurate proportioning and thorough mixing.

If the coarse aggregate used in stone matrix asphalt, open graded friction course, or SC types A and B has an absorption >0.80 percent when tested as specified in T 85, the antistripping additive used shall be hydrated lime conforming to C 1097. Coarse aggregate having an absorption <0.80 percent shall be treated with either hydrated lime or a prequalified heat stable antistripping additive.

When hydrated lime is used, it shall be added in a slurry form at the rate of 1.0 to 1.5 percent by weight of total aggregate. Lime slurry shall be sprayed uniformly on the damp, cold aggregate on the feed belt prior to entry into the HMA plant dryer.

Plant control and acceptance of the mix shall be based on MSMT 410 with respect to its stripping potential.

904.06.05 Plant Control. The following tolerances shall apply:

TABLE 904 B - MIX TOLERANCES

PHYSICAL PROPERTY	TOLERANCE
Passing No. 4 sieve and larger, %	± 7 (a)(b)
Passing No. 8 thru No. 100 sieve, %	± 4 (a)
Passing No. 200 sieve, %	± 2
Asphalt content, %	± 0.4
Ratio of dust to binder material, max	1.2 (c)
Mix temperature leaving plant versus design mix temperature, F (C)	± 25 (14) (d)
Deviation of maximum specific gravity per lot versus design maximum specific gravity	± 0.030 (e)
Voids, total mix, %	4 ± 1 (3 ± 2 for SR mix)
Voids in mineral aggregate, %	-1.8 from design target

(a) The design mix tolerance shall not fall outside the specified gradation limits in Table 901 C.

(b) ± 2 for BF on 1 in. sieve.

(c) Not applicable to OGFC or SR.

(d) ± 15 F (8.3 C) for OGFC.

(e) Not applicable to OGFC.

PWSL computations shall be performed for maximum specific gravity, voids in the total mix and voids in the mineral aggregate. This computation shall be performed as specified in 504.04.02 using the moving average of the last three consecutive test values for each parameter. If the PWSL for the three test values fall below 85, corrective action shall be taken to bring the PWSL to at least 85. If the PWSL drops below 68, production shall be suspended until corrective action is taken as approved by the Engineer.

OGFC. The following shall apply:

- (a) **Batch Plant.** Minimum of 2 hot bins.
- (b) **Drum Mixer.** May be used if the average of five consecutive asphalt contents and gradations meet the original design and applicable tolerances shown in Table 904 B, and no value falls outside the gradation as specified in Table 901 C. A minimum of two cold feed bins shall be used.

904.06.06 Contractors Control Test Responsibility. The Contractor shall provide quality control tests, performed in accordance with AASHTO procedures, when the total quantity of bituminous concrete delivered to all County projects exceeds 150 tons in an eight-hour shift.

The required tests and their frequencies are:

- (a) **Mix Gradation:**
 - (1) Batch Plant (combined hot bin analysis): two tests per eight-hour shift.
 - (2) Drum Plant (Belt cut): two tests per eight-hour shift.
- (b) Maximum Specific Gravity of completed mixture: two tests per eight-hour shift.
- (c) Asphalt cement content (solvent extraction or nuclear): one test per eight-hour shift.
- (d) Marshall Stability, Flow and Plug Specific Gravity (minimum two plugs): one test per eight-hour shift.

Tests shall be reported in writing no later than 1:00 PM on the day following the mix production to a materials testing laboratory as directed by the Engineer.

SECTION 905 - PIPE

905.01 Certification. The manufacturer shall furnish certification for all pipe as specified in TC-1.02.

MATERIAL	SPECIFICATION	REMARKS
Nonreinforced Concrete Pipe	M 86, Class 3	-
Reinforced Concrete Pipe	M 170, Class 4	54 in. (1350 mm) and smaller diameter M 170, load bearing option. 60 in. (1500 mm) and larger diameter M 170, material option.
Concrete End Sections	M 170	-
Polyethylene (PE) Plastic Drain Tube or Pipe	M 252 or M 294	-
	M 252	underdrain outlet pipes Type S minimum pipe stiffness 50 psi
Polyvinyl Chloride (PVC) plastic Pipe & Drain Pipe	AASHTO Bridge Section 18 PVC Ribbed Pipe	-
	M 278	underdrain outlet pipes
Reinforced Concrete Arch Culvert	M 206	-
Reinforced Concrete Elliptical Pipe	M 207	horizontal elliptical pipe only.
Preformed Rubber Joint for Circular Pipe	M 198, Type A	-
Corrugated Steel Pipe, Pipe Arches & Underdrain	M 36	-
Corrugated Aluminum Alloy Pipe	M 196	-
Structural Plate for Pipe, Pipe Arches & Arches	M 167	-
Polyethylene (PE) Precoated Corrugated Steel Pipe	M 245 & M 246	minimum thickness 10 mil (0.25 mm) on each of the surfaces.
Concrete Drain Tile	M 178	-
Polyvinyl Chloride (PVC) Plastic Pipe	F 758, Type PS 28	Perforated Underdrain
Poly Vinyl Chloride (PVC) Sewer Pipe	ASTM D 3034 SDR 35 (8" - 15") ASTM F 794 (18"-30")	Jointing ASTM D 3212 "Push on Joints" using locked in elastomeric seal.

MATERIAL	SPECIFICATION	REMARKS
Reinforced Concrete Sewer Pipe, Pressure Type Non-cylinder	AWWA A 302	Packer head pipe not permitted. Elliptical or quadrant steel not permitted. Class of pipe in accordance with ASTM C 76. Type II cement. Detail drawings and schedules, Sec. 1.5.1 and Affidavit Sec 1.10 to be provided.
Cast Iron Soil Pipe	ASTM A-74 Extra Heavy	Caulked lead or ASTM C 54 joints
Prestressed Concrete Pressure Pipe, Steel Cylinder Type	AWWA C 301	Detail drawings and schedules Sec. 1.5.1 and Affidavit Sec. 1.10 to be submitted.
Steel Pipe	AWWA C 202	Coating as Specified
Ductile Iron Pipe	AWWA C 151 AWWA C 150	Gravity Sewer: Class 52. Water and Sanitary Sewer Force Mains: Class 54. Pressure Rating through 24" 350 psi. 30 - 48" 300 psi. Fitting AWWA C 110 and C 153
Copper Pipe	ASTM B-88 Type K	

905.02 Cast Iron Pipes and Fittings — Water Mains

905.02.01 Substitute: Ductile Iron Pipe according to Section 905.01 (table) is an acceptable substitute for this item.

905.02.02 Pipe:

- (a) **Requirements.** Pipe must conform to the requirements of the standards of the Water Supply Division as adopted February 23, 1956 or as amended. It must also meet the requirements of Federal Specification WW-P-421B1 (September 7, 1962) covering Type I, Caulked Joint, and Type III, Mechanical Joint, Centrifugally Cast Pipe, except that the metal thickness must be increased as tabulated herein or as required. The push-type rubber gasket joint must conform to AWWA C 106, AWWA C 111, and ANSI A-21.11.
- (b) **Lengths per Size of Pipe.** Pipe 16 in. (41 cm) and larger must be A-B Pattern. Pipe nominal lengths may be 16, 16-1/2, 18 or 20 ft (4.8, 5, 5.5 and 6.1 m).
- (c) **Thickness Determination for Cast Iron Pipe.** For cast iron pipe furnished by the Contractor, use the following table to determine minimum wall thickness:

MINIMUM WALL THICKNESS
FOR CAST IRON PIPE

(Inches) Class	Wall Thickness (Inches)	Outside Diameter (Inches)	Water Working Pressure 5 Feet Cover*
3 22	.32	3.96	350 psi
4 22	.35	4.80	350 psi
6 22	.38	6.90	350 psi
8 22	.41	9.05	350 psi
10 23	.48	11.10	300 psi

12	23	.52	13.20	300 psi
16	23	.58	17.40	200 psi
20	23	.67	21.60	200 psi
24	24	.79	25.80	250 psi
30	24	.92	32.00	200 psi
36	24	1.02	38.30	200 psi
42	24	1.13	44.50	200 psi
48	25	1.33	50.80	250 psi

*Laying Condition B

(d) Design Notes. All pipe and pipe fittings must be designed to withstand external pressure caused by overburden indicated on the profile, traffic loads or other loads to which the pipe may be subjected. Increase the thickness if required due to a change in laying conditions or to excessive cover. Determine design thickness from ANSI A 21.6 and A 21.8 or AWWA C 106 and C 108.

905.02.03 Joints. Joints on pipe must be lead, mechanical or rubber-gasket push type. Accessories and installation must be as specified under Federal Specification WW-P-421 B or as recommended by the manufacturer.

905.02.04 Fittings. All fittings must be according to the latest standards of the Water Supply Division and the appropriate ANSI and AWWA specifications. They must be designed and constructed to withstand a pressure not less than that for the adjacent pipe. Fittings 12 in. (30 cm) and smaller generally are to be Class 250 or Class D. Those 16 in. (41 cm) and larger generally are to be Class 150 or Class B.

905.02.05 **Coating:** All pipe and fittings must be cement-lined standard thickness. The lining must be sealed with bituminous seal coat. The outside surface must be bituminous-coated.

905.03 STEEL PIPE

905.03.01 **ASTM Requirement: ASTM A120, Standard Weight**

905.03.02 **Pipe and Fittings.**

(a) **AWWA Requirements.** Pipe and fittings must be according to AWWA C 202. Pipe must have plain ends suitable for flexible couplings or flanged ends as shown on the Plans. Pipe must be furnished in the lengths shown on the Plans.

(b) **Cleaning and Coating.**

(1) **Interior Surface.** Clean the interior surface of all steel pipe, prime and line with coal-tar enamel.

(2) **Exterior of Pipe to be Placed Underground.** Clean and coat with coal-tar primer, followed by a hot coat of coal-tar enamel into which bond an asbestos felt wrapper. Finish with Kraft paper or one coat of water-resistant whitewash.

(3) **Exterior of Pipe to be Placed Above Ground.** Clean thoroughly and apply one coat of pure red lead and linseed oil before leaving the shop. After installation, apply field coats to the pipe as specified in the Special Provisions.

(c) **Flexible Couplings.**

These must be Dresser couplings, or approved equal, of the style indicated on the Plans. Couplings, bolts and nuts must be galvanized. Do not remove middle ring unless specified on the contract drawings.

(d) **Flanges Pipe.** Flanges must be of the welded slip-on type, fabricated or forged steel, and must conform to all applicable requirements of ANSI B16.5, 150-pound standard. Flanges joining pipe ends must be bored, faced, drilled and back-faced according to ANSI B16.5, 150-pound Standard. Flanges serving as part of the

pipe anchor must be bored only. Weld all flanges to the pipe before lining the interior surface of the pipe.

905.03.03 Expansion Joints. These must be Dresser Expansion joints, Style 63, Type 1, or approved equal. Chrome-plated slip pipe must be furnished by the expansion joint manufacturer. The ends of the expansion joints must be flanged. Flanges must be as specified in Subsection 905.03.02 D above.

905.03.04 Hanger Rods and Concrete Inserts. Hanger rods, washers and nuts must be of structural steel conforming to ASTM A306. Concrete inserts must be of malleable iron. Hanger rods, washers, nuts and concrete inserts are to be approved by the Engineer.

905.03.05 Pipe Rolls and Sockets. Pipe rolls and sockets for pipe hangers must be Crane, Figure No. 171-G, or approved equal. Pipe rolls, sockets, rods and nuts for latest pipe supports must be Crane, Figure 17-C or approved equal.

905.04 FIRE HYDRANTS, WATER VALVES, METERS AND APPURTENANCES

905.04.01 Fire Hydrants.

- (a) **Approved Models Only.** Fire hydrants approved by Baltimore City Department of Public Works are accepted. Currently approved models are:

U.S. Pipe and Foundry Smith Model H 205
American Darling Valve Company Model B-62-B
Mueller Company A-463 Centurion
Dresser Manufacturing Company Reliant Style 929
Kennedy Valve Company Guardian Model K-81

- (b) **Hydrant Design.** Hydrant design must be “Traffic Model” which breaks at the ground level when struck.
- (c) **Operating Nut and Cap Nuts.** Operating nuts must be 5-sided, pentagonal-shape, measuring 1-3/8 in. (3.5 cm) from the point to the flat on the top surface. To open the hydrant, the nut must turn counter-clockwise. Show the direction of the opening on the bonnet with a raised arrow.
- (d) **Elbow (Inlet Connection).** The elbow must be Cast or Ductile Iron, standard 6-inch mechanical joint on the inlet end and a flanged connection on the standpipe end.
- (e) **Hose Connections.** There must be one 4-1/2 in. (11.4 cm) pumper connection with Baltimore City Standard Threads as shown on Standard Detail Plate W3C and two 2-1/2 in. (6.35 cm) hose connections with National Standard Threads.
- (f) **Valve Size.** The main valve size must be 5 in. (12.7 cm) minimum.
- (g) **Paint.** Paint must conform to AWWA Sections 2.22 and 4.6. The final coat of paint above the groundline must be Sherwin Williams, Kem L-F65, E-36, Safety Orange Lead-Free Industrial Enamel or approved equal.
- (h) **Bury.** The depth of bury must be the distance measured from the base of elbow to the groundline set by the manufacturer. Hydrants must be furnished to a 5-ft (1.524 m) bury unless noted otherwise on the Plans.

905.04.02 Water Valves.

- (a) **Requirements.** Valves and appurtenances must conform to the specifications and requirements of the Department of Public Works of Baltimore City. Valves, tapping tees and sleeves must be “Balti-

more Standard” as manufactured by the A.P. Smith Manufacturing Co., M & H Valve and Fittings Company or approved equal.

- (b) **Valve Hub Dimensions.** Must conform to the following Bureau of Water Supply Standards and classifications:

Mechanical Joint

12 in. (30 cm) and smaller	Class 150
16 in. (41 cm) and larger	Class 100

Lead Joint

12 in. (30 cm) and smaller	Class D
16 in. (41 cm) and larger	Class B (approx.)

- (c) **Tapping Sleeves and Valves.** Material for tapping sleeves and valves for cast iron pipe may be either caulked-lead type or mechanical joint type. Tapping sleeves must be furnished with an outlet for testing. Before making the tap, provide facilities for testing and test the tapping sleeve and valve. Make and install tapping sleeves and valves for prestressed concrete pipe according to the manufacturer’s recommendation.

- (d) **Special Castings.** Valve vaults, frames and covers, roadway valve boxes or other special castings and other materials must be of the sizes, patterns and materials shown on the Standard Detail Drawings or as directed by the Engineer.

905.04.03 Water Meter Settings.

- (a) **Meter Yokes.** Meter yokes must conform to the requirements of the Department of Public Works of Baltimore City. They must be manufactured by the Ford Meter Box Company, Inc. or approved equal. They must be furnished with bolt ends suitable for copper tubing. They must also include expansion connections for the meter.

(b) Fittings. Fittings must be of the size and type shown on the Standard Details and according to the following information:

- (1)** Corporation stop with coupling nut at main must be Mueller H-1500 or approved equal.
- (2)** Male iron pipe thread (M.I.P.T.) copper connections, if required, at curb stop on meter yoke must be Mueller H-15425 or approved equal.
- (3)** Copper couplings to connect terminal ends of copper tube must be Mueller H-15405 or approved equal. Do not use sweat joints to make connection on terminal ends of copper tubing.
- (4)** Brass meter spreader for twin connection must be 7-1/2 in. (19 cm) center-to-center with male thread ends and must be Mueller H-15366 or approved equal.
- (5)** Brass connection at service end must be Mueller H-15450 or approved equal.
- (6)** Provide all service ends not connected to house service with an iron or brass pipe plug to prevent any foreign matter from entering the pipe.

SECTION 906 - GABIONS

906.01 WIRE FOR GABIONS. The wire shall have a minimum tensile strength of 60 000 psi (414 Mpa) when tested as specified in A 370. All wire sizes and mesh spacing shall be as recommended by the manufacturer. Tie and connecting wire shall also conform to this Specification.

Stainless steel interlocking fasteners may be substituted for wire ties. The fasteners shall conform to A 313. When subjected to directional tension along its axis, the fastener shall remain in a closed and locked condition for a minimum force of 900 lb (4.0 kN).

906.01.01 Galvanized Coating for Gabions. Galvanized coating for fabric, ties, and connecting wire shall not be less than 0.8 oz/ft² (240 g/m²) when tested as specified in A 90.

906.01.02 Polyvinyl Chloride (PVC) Coating for Gabions. PVC coating for fabric, ties, and connecting wires for gabions shall exhibit no weight loss when tested as specified in MSMT 508. Color shall conform to Federal Standard 595, gray color No. 26440 or green color No. 24533 and shall match throughout the project.

SECTION 907 - PILES AND PILING

907.01 TIMBER PILING. Timber piling shall conform to M 168.

907.01.01 Resin and Fiberglass Caps for Timber Pile Heads. Resin and fiberglass for use in protecting timber pile heads shall conform to the following:

MATERIAL	SPECIFICATION	REMARKS
Reinforced Concrete Sewer Pipe, Pressure Type Non-cylinder	AWWA A 302	Packer head pipe not permitted. Elliptical or quadrant steel not permitted. Class of pipe in accordance with ASTM C 76. Type II cement. Detail drawings and schedules, Sec. 1.5.1 and Affidavit Sec 1.10 to be provided.
Cast Iron Soil Pipe	ASTM A-74 Extra Heavy	Caulked lead or ASTM C 54 joints
Prestressed Concrete Pressure Pipe, Steel Cylinder Type	AWWA C 301	Detail drawings and schedules Sec. 1.5.1 and Affidavit Sec. 1.10 to be submitted.
Steel Pipe	AWWA C 202	Coating as Specified
Ductile Iron Pipe	AWWA C 151 AWWA C 150	Gravity Sewer: Class 52. Water and Sanitary Sewer Force Mains: Class 54. Pressure Rating through 24" 350 psi. 30 - 48" 300 psi. Fitting AWWA C 110 and C 153
Copper Pipe	ASTM B-88 Type K	

907.02 CASINGS FOR CAST-IN-PLACE CONCRETE PILES.

Steel shells or casings shall be formed from a single piece of metal having not more than one continuous welded seam. The seam shall have a minimum yield strength of 28 000 psi (193 MPa). Tips shall conform to A 36.

907.03 STEEL BEARING PILES. Steel bearing piles and steel bearing pile splice material shall conform to A 36.

907.04 STEEL SHEET PILES. Steel sheet piles shall conform to A 328. Sheet pile accessories shall conform to A 36. High strength bolts shall conform to 909.07.

907.05 WELDING MATERIALS. Welding materials shall conform to ANSI/AWS D1.5.

SECTION 908 - REINFORCEMENT STEEL

908.00 CERTIFICATION. The steel manufacturer shall furnish certification for each heat of steel as specified in TC-1.02.

908.01 DEFORMED REINFORCEMENT. Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy powder shall conform to 917.02.

908.02 PLAIN REINFORCEMENT. Unless otherwise specified, dowel bars and dowel bars used as ties in portland cement concrete pavement expansion and contraction joints shall be plain round steel bars conforming to A 615, Grade 60 or A 36. Bars shall be epoxy coated. Epoxy powder shall conform to 917.02.

908.03 STAINLESS STEEL BARS. In lieu of epoxy coated plain bars, the Contractor may use stainless steel bars. Deformed bars shall be stainless steel when specified in the Contract Documents. Stainless steel shall

conform to A 276, Type SM-29. Deformed stainless steel bars shall conform to A 615 for cross sectional area and deformations.

908.04 SLEEVES FOR DOWEL BARS IN PAVEMENT EXPANSION JOINTS. Sleeves for dowel bars shall be of sheet metal capable of sliding over $2 \pm 1/4$ in. (50 ± 6 mm) of the dowel and shall have a closed end with a stop to hold the end of the sleeve at a minimum distance of 1 inch (25 mm) from the end of the dowel bar.

908.05 WELDED STEEL WIRE FABRIC. Welded steel wire fabric shall conform to M 55. Fabric used in pavement construction shall be furnished in flat sheets.

908.06 WELDED DEFORMED STEEL WIRE FABRIC. Welded deformed steel wire fabric shall conform to M 221.

908.07 FABRICATED STEEL BAR MATS. Fabricated steel bar mats shall consist of steel conforming to A 184.

908.08 WIRE FABRIC FOR PNEUMATICALLY APPLIED MORTAR. Wire fabric for pneumatically applied mortar and concrete encasement shall conform to A 185. It shall be fabricated either from size W1.5 wire on 3 in. (75 mm) centers in each direction or from W1 wire on 2 in. (50 mm) centers in each direction. It shall be galvanized as specified in 906.01.01.

908.09 COLD DRAWN STEEL WIRE. Cold drawn steel wire for concrete reinforcement shall conform to M 32.

908.10 TIE DEVICES FOR CONCRETE PAVEMENT. Tie device sizes shall be as specified in the Contract Documents and produce a frictional force of at least 160 lb/ft per foot (7660 N/m per meter) of spacing when tested as specified in MSMT 512.

908.11 STRESS RELIEVED STRAND. Stress relieved strand shall conform to M 203, Grade 270.

908.12 STRESS RELIEVED WIRE. Stress relieved wire shall conform to M 204, Type WA.

SECTION 909 - METALS

909.00 CERTIFICATION. The metal producer shall furnish certification as specified in TC-1.02. The certification shall include actual mill test results. The chemical and physical properties of the finished metal products shall also be furnished by the processing manufacturer.

909.01 STRUCTURAL STEEL. Structural steel shall conform to the requirements specified in the Contract Documents. All primary load carrying members shall conform to the supplementary toughness requirements of M 270, Zone 2.

Primary load carrying members are as follows or as designated in the Contract Documents: Finger joint steel from which saw tooth configurations have been cut, all stringers, cover plates, bearing stiffeners, splice plates, pins and pin links for straight rolled steel beam bridges; all flanges, webs, bearing stiffeners, splice plates, pins and pin links for straight steel girder bridges. Additionally, on curved rolled steel beam and steel girder bridges; all diaphragms, cross frames, lateral bracing, including connection plates to main stringers.

909.02 STEEL FOR MISCELLANEOUS USE. Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

909.03 WELDING MATERIALS. Welding materials shall conform to ANSI/AWS D1.5.

909.04 GRAY IRON CASTINGS. Iron castings shall conform to A 48, Class 30B.

909.05 STEEL STUD SHEAR DEVELOPERS. Shear developers shall conform to ANSI/AWS D1.5.

909.06 BOLTS, NUTS AND WASHERS FOR GENERAL USE.

Bolts, nuts and washers for general use shall conform to A 307, and shall be galvanized as specified in A 153. Anchor bolts shall be galvanized and shall conform to A 709, Grade 36.

909.07 HIGH STRENGTH BOLTS, NUTS AND WASHERS. High strength bolts, nuts and washers shall conform to A 325.

909.07.01 Anchor Bolts for Traffic Signals, Highway Lighting, and Signs. Anchor bolts for traffic signals, highway lighting, and signs shall conform to M 314, grade 55 S1. Anchor bolts shall be galvanized for the full length of the threads and 3 in. below the threads in conformance with A 153. Nuts shall be heavy nuts conforming to A 194, grade 2 or 2H. Flat washers shall be heavy washers conforming to F 436. All hardware shall be galvanized in conformance with A 153.

909.08 CAST WASHERS. Cast washers, ogee washers and special cast washers shall conform to A 47. Cast washers shall be mechanically or hot dip galvanized. The coating shall conform to the thickness, adherence and quality requirements of A 153.

909.09 HARDWARE. Spikes, wood screws, staples, brads, lag screws, carriage bolts and other parts under the general heading of HARDWARE shall be composed of carbon steel and shall conform to Federal Specification FF-N-105.

909.10 STEEL FORMS. Steel bridge deck forms and deck form supports which remain in place shall be fabricated from steel conforming to A 446, Grades A through E, Coating Designation G 165. The minimum thickness of uncoated steel shall be 0.0359 in. (0.912 mm).

SECTION 910 - BEARINGS

910.00 CERTIFICATION. The bearing producer shall furnish certification as specified in TC-1.02. The certification shall include actual mill test results. The chemical and physical properties of the finished bearings shall also be furnished by the processing manufacturer.

910.01 BRONZE OR COPPER ALLOY BEARING AND EXPANSION PLATES. Bronze or copper alloy plates shall be either of cast bronze or rolled copper alloy.

910.01.01 Cast Bronze. Cast bronze bearing and expansion plates shall conform to B 22, Alloy No. 91100 or No. 91300.

Self lubricating bronze bearing plates shall be an article of standard production by an established manufacturer of such equipment. They shall be provided with trepanned recesses (not grooves) that shall be filled with a lubricating compound consisting of graphite and metallic substances with a lubricating binder capable of withstanding the atmospheric elements. The lubrication compound shall be compressed into the recesses by pressure to form dense, nonplastic lubricating inserts. The lubricating area shall comprise not less than 25 percent of the total area. The static co-efficient of friction shall not exceed 0.10.

The certification shall be as specified above and shall include the actual test results showing that bearing plates of the same design as those supplied conform to the static coefficient of friction requirements.

The test specimens shall measure not less than 4 in. (100 mm) long by 4 in. (100 mm) wide. The static coefficient of friction shall be determined by testing a specimen plate subjected to a vertical pressure of 1000 psi (6.9 Mpa) and 1000 cycles consisting of 1/2 in. (13 mm) horizontal strokes at a speed not to exceed 9 cycles per minute. Testing shall be conducted at an ambient temperature of 77 ± 9 F (25 ± 5 C). The static coefficient of friction on the specimen bearing plate shall be calculated by dividing the total applied vertical load on the plate into the total horizontal load required to start motion between the bearing plate and its mating surface while subject to the vertical load. Upon completion of the test, the bronze plate shall show no signs of galling.

910.01.02 Rolled Copper. Rolled copper alloy bearing and expansion plates shall conform to B 100, Alloy No. 51000.

910.02 STRUCTURAL BEARING PADS. The manufacturer shall furnish certification as specified in TC-1.02.

910.02.01 Elastomeric Pads. Elastomeric bearing pads shall conform to the material requirements described in the AASHTO Standard Specifications for Highway Bridges. The elastomeric bearing shall be 60 durometer hardness, Shore Type A. Accompanying the certificate for elastomeric bearing pads shall be two standard ASTM tensile slabs molded from the same compound batch as the furnished elastomeric bearings.

The static load deflection of any layer of elastomeric bearing pads shall not exceed seven percent at 800 psi (5.5 MPa) average unit pressure when tested under laboratory conditions.

The design load for the elastomeric bearing pads will be specified in the Contract Documents. The manufacturer shall proof load each steel reinforced bearing with a compressive load of 1.5 times the maximum design load and shall specify that the material conforms to the material certification.

When test specimens are cut from an actual bearing pad, a reduction of 10 percent in the minimum requirements for original tensile strength and ultimate elongation will be required.

910.02.02 Self Lubricating Bearing Assembly. Self lubricating bearing assembly shall consist of a fabric reinforced elastomeric pad, Tetrafluoroethylene (TFE) bonded to the pad, and a stainless steel sheet. All the elements shall conform to AASHTO Standard Specifications for Highway Bridges as modified herein.

Fabric reinforced elastomeric pad shall be Type A, durometer hardness of 70-90. Stainless steel sheet shall be Type 304, minimum thickness of 16 gauge (1.519 mm). The surface of the stainless steel sheet in contact with Tetrafluoroethylene shall have 2B finish, and shall be welded to the sole plate using a welding procedure approved by the Engineer.

910.02.03 Preformed Fabric Pads for General Application. Preformed fabric pads shall be composed of multiple layers of 8 oz cotton duck impregnated and bound with high quality natural rubber or of equally suitable

materials, approved by the Engineer and compressed into resilient pads of uniform thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10 000 psi (68.9 MPa) without detrimental reduction in thickness or extrusion.

SECTION 911 - JOINTS

911.01 JOINT SEALER AND CRACK FILLER. Joint sealer and crack filler shall conform to D 3406 as modified by MSMT 404. The manufacturer shall furnish certification as specified in TC-1.02. Manufacturer's recommendations regarding heating and pouring temperatures will be used when testing these materials. If a range of temperatures is recommended, the midpoint will be used as the pour point.

911.01.01 SILICONE JOINT SEALER AND CRACK FILLER. Silicone joint sealer and crack filler shall be low modulus, one component compound which may or may not require a primer for bonding to concrete. If a primer is required, it shall be as recommended by the sealant manufacturer and shall be placed on the joint faces following the insertion of the backup material.

Silicone material, when tested at 73 ± 3 F (22.8 ± 1.67 C) and 45-55 relative humidity, shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Shore A Hardness, at 7 days	D 2240	10-25
Tensile Strength at 150% Elongation, psi (kPa) max	D 412 Die C	45 (310)
Elongation, % min	D 412 Die C	700
Adhesion in Peel, lb/in. (N /m) min	Federal Spec TT-S-00230	20 (2.2)
911.02 PREFORMED JOINT FILLERS. Preformed joint fillers shall conform to M 153. Flow, 0.01 in. (0.3 mm) max	T 187	0.3
Tack-Free Time, minutes	D 2377	20-75

Each container of silicone sealer and crack filler shall have a minimum shelf life of six months. Material more than six months old shall be retested.

911.02 PREFORMED JOINT FILLERS. Preformed joint fillers shall conform to M 153. The bituminous fiber type shall conform to M 213, with the bitumen content determined by MSMT 408 or T 164. The weathering test shall be deleted for either type of material.

911.03 PREFORMED JOINT INSERTS. Preformed inserts shall conform to M 220 or D 2828.

911.04 PREFORMED POLYCHLOROPRENE ELASTOMERIC COMPRESSION JOINT SEALS. The manufacturer shall furnish certification as specified in TC-1.02.

911.04.01 Roadway Seals. Roadway seals for concrete pavement shall conform to M 222.

Force deflection shall conform to M 220.

911.04.02 Bridge Seals. Bridge seals shall conform to M 297.

The minimum depth of all seals measured at the contact surface shall be at least 90 percent of the minimum uncompressed width of the seal.

911.04.03 Lubricant Adhesive. The lubricant adhesive shall be compatible with the preformed joint seals and concrete. The Engineer will determine that consistency is suitable at the time of installation.

The manufacturer shall furnish certification as specified in TC-1.02 showing that lubricant adhesive conforms to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Solids, D 553, % min	22
Film Strength, D 412, psi (MPa) min	2000 (13.8)
Elongation, D 412, % min	250

No lubricant adhesive shall be used after nine months from the date of manufacture. Each container shall be plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture.

911.05 NEOPRENE STRIP SEALS. The manufacturer shall furnish certification as specified in TC-1.02 showing that the neoprene strip seals conform to the following:

PHYSICAL PROPERTIES FOR PREFORMED ELASTOMERIC STRIP SEALS		
PROPERTY	REQUIREMENT	TEST METHOD
Tensile Strength, psi, min (MPa)	2000 (13.8)	D 412
Elongation at Break, %, min	250	D 412
Hardness, Type A Durometer, points	60 ±5	D 2240 (modified)(a)(c)
Oven Aging, 70 h @ 212 F (100 C) Tensile Strength, % loss, max Elongation, % loss, max Hardness, Type A Durometer, points change	20 20 0 to +10	D 573 D 2240 (modified) (a)(c)
Oil Swell, ASTM oil 3 70 h at 212 F (100 C) weight change, % max	45	D 471
Ozone Resistance 20% strain, 300 pphm in air, 70 h at 104 F (40 C)	No Cracks	D 1149 (modified)(b)
Low Temperature Stiffening 7 days at 14 F (-10 C) Hardness, Type A Durometer, points change	0 to +15	D 2240 D 2240 (modified) (a)(c)
Compression Set, 70 h at 212 F (100 C), % max	40	D 395 Method (modified) (b)(a)

(a) The term "modified" in the table relates to the specimen preparation. The use of the strip seal as the specimen source requires that more piles than specified in either of the modified test procedures be used. Such specimen modification shall be agreed upon by the purchaser and producer or supplier prior to testing

(b) Test in conformance with procedure A of D 518 and ozone concentration is expressed in pphm.

(c) The hardness test shall be performed with the durometer in a durometer stand as recommended in D 2240.

911.05.01 Special Molded Intersection Pieces. Where joint elements intersect, a special strip seal element manufactured by molding in one piece from neoprene material similar to that specified above shall be 10 in. (250 mm) from point of intersection to nearest end along center line of joint in any direction. Ends shall be plane and square to facilitate bonding to adjacent extruded areas, and corners of sharp angles shall be rounded sufficiently to relieve damaging stress concentrations. Angles to which moldings are fabricated shall be within 5 degrees of the actual angle as specified in the Contract Documents to avoid excessive deformation when installed in steel joint components.

Lubricant adhesive for use in installing and bonding neoprene seal elements to steel joint components shall be one part moisture curing polyurethane and hydrocarbon solvent mixture having the following physical properties:

TEST AND METHOD	SPECIFICATION LIMITS
Average Weight, lb/gal (kg/l)	8 ±0.8 (1.0 ±0.1)
Solids Content, % min	65
Adhesives shall remain liquid from, F (C)	5 to 120 (-15 to 49 C)
Film Strength, D 412, psi (MPa) min	2000 (13.8)
Elongation, D 412, % min	250

Steel extrusions and neoprene seals shall be matching components by the same manufacturer. The steel extrusions shall have a minimum thickness of 3/8 in. (10 mm). All steel portions of the joint assembly shall be fusion bonded epoxy coated after assembly in conformance with Section 917.

911.06 SEALER FOR LOOP DETECTOR. Sealing material to seal saw cuts for loop detector wires shall be either Type A, two part epoxy or Type B, one part polyurethane. The manufacturer shall furnish certification as specified in TC-1.02. No aggregate shall be mixed with the sealer material. The sealer shall be applied in conformance with the manufacturer's recommendations.

911.06.01 Tests. Tests shall conform to the following:

TYPE A - TWO PART EPOXY	
TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, cone and plate Viscometer @ 25 C, cps max	12 000
Pot life @ 25 C, minutes min	10
Cure time @ 25 C, no tackiness, hr max	1
Hardness, Type A durometer, D 2240	50 - 60
Tensile elongation, D 638, % min	100
Water absorption, D 570, %/24 hr max	0.5
Oil absorption, D 471, % max	0.02
Volume resistivity @ 25 C, D 257, ohm-cm min	2.4×10^{10}

TYPE B - ONE PART POLYURETHANE	
TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, Brookfield RVF #6 spindle @ 20 rpm 25 C, cps max	30 000
Cure time @ 25 C, no tackiness, hr max	24
Hardness, Rex Type A, Model 1700, min	70
Tensile Strength, D 412, psi (MPa) min	500 (3.4)
Tensile Elongation, D 412, % min	300
ARC Resistance, D 495, sec min	70
Dielectric Constant, D 150, min	6 @ 50 hz 4.25 @ 500 khz
Nonvolatile Content, %	85

911.07 ROOFING PAPER. Roofing paper to be used in expansion joints shall be composed of roofing felt saturated and coated on both sides with an asphaltic material. It shall not weigh less than 39.8 lb/100 ft² (1.94 kg/m²) and shall not crack when bent 90 degrees over a 1/2 in. (13 mm) radius at room temperature.

911.08 WATERSTOPS. Waterstops shall be made of rubber or polyvinylchloride (PVC).

The waterstop shall be of the shape and dimensions specified in the Contract Documents. The cross section shall be uniform along its length and transversely symmetrical so that the thickness at any given distance from either edge of the waterstop shall be uniform.

The waterstop shall conform to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Tensile Strength, D 412, psi (MPa) min	2000 (13.8)
Elongation @ Break, D 412, % min	300
Hardness, Rubber, Type A durometer, D 2240	55 ±5
Hardness, PVC, Type A durometer, D 2240	75 ±5

The Contractor shall furnish a test sample for each lot or shipment of waterstop. The manufacturer shall furnish certification as specified in TC-1.02.

911.09 ASPHALT SEALER FOR CONCRETE PIPE. The sealer shall be a mixture of asphalt, mineral filler, and petroleum solvents, and shall have adhesive and cohesive properties.

911.10 CLOSED CELL NEOPRENE SPONGE ELASTOMER.

Closed cell neoprene sponge elastomer shall conform to D 1056, Type S. Skin coating is optional. The material shall conform to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Compression Deflection, D 1056	Pressure necessary for 25 % deflection, 5 – 10 psi (34.5 - 69.0 kPa), one layer ½ in. (13 mm) thick pad @ 70 ±5 F (21 ±2.8 C)
Accelerated Aging Test	Change in compression deflection after aging 7 days @ 158 F (70 C), 20 % max
Permanent Set*, D 1056	50 % deflection @ 158 F (70 C) for 22 hr, 40 % max residual permanent set after 10 days recovery, 10 % max
Water Absorption by weight	2 in. (50 mm) immersion of 1.129 in. (28.58 mm) diameter sample for 24 hr @ room temperature, 10 % max
Water Resistance, D 1171	Quality retention, 6 weeks exposure, 100 %

* Method to calculate permanent set:

$$\text{Permanent set} = \frac{(t_0 - t_1) \times 100}{t_0}$$

where:

t_0 = original thickness of sample, and

t_1 = thickness of specimen 30 minutes after removal of clamps or after 10 days recovery.

911.11 Neoprene Drainage Troughs. Neoprene for drainage troughs shall conform to M 220, and the following:

PHYSICAL PROPERTY	TEST METHOD	SPECIFICATION
Tensile Strength, psi min	D 412	2000
Elongation at Break, % min	D 412	250
Hardness, Type A Durometer	D 2240 (modified)	60 ±5
Compression Set, 70 hr @ 212 F (100 C), % max	D 395	40
Oven Aging, 70 hr @ 212 F (100 C)		
Tensile Strength, % loss max	D 573	20
Elongation, % loss max		20
Hardness, Type A Durometer (points change)		0 to +10

SECTION 912 - PAINTS

912.01 GENERAL. The paint manufacturer shall furnish certification for each lot and color of paint as specified in TC-1.02. The Administration will perform independent tests to determine conformance with this Specification. Paints shall be tested in conformance with Federal Test Method Standard 141. Unless otherwise specified, color shall be No. 30045 in conformance with Federal Standard 595. Only one formulation per color will be permitted per project. All paint shall be satisfactory for brushing or spraying. All paint systems shall be from the same manufacturer. Paint shall be shipped in the original containers. All containers shall bear the identifica-

tion of the paint. The identification shall consist of the following: manufacturer's name, the name or title of material, volume of the contents, manufacturer's stock number, the date of manufacture, contents by volume for major pigment and vehicle constituents, thinning instructions, application instructions, color name and number, handling instructions and precautions, and the batch number.

912.01.01 Tolerances. Unless otherwise specified, the following tolerances shall apply to the paint provided, when compared to the manufacturer's submitted target values:

TEST	TOLERANCE
Total Solids by weight, %	±2
Pigment Content by weight, %	±2
Vehicle Solids by weight, %	±2
Viscosity, KU	±10
Unit Weight, lb/gal (kg/l)	±0.5 (0.06)
V.O.C.	Current EPA Regulation

912.02 RAW LINSEED OIL AND ALKYD PRIMER. Raw linseed oil and alkyd primer shall conform to SSPC-Paint 25, and shall be tinted to differentiate between first and second coats.

912.03 INORGANIC ZINC RICH PRIMERS. Water based inorganic zinc rich primers shall conform to M 300, Type II, except that the viscosity requirements may be exceeded, but shall be within ±10 KU of the manufacturer's original certification results.

Low Volatile Organic Compound (VOC) inorganic zinc rich primers shall be solvent based two component materials conforming to M 300, Type I, except that the VOC shall not exceed current EPA limits and the viscosity shall be within ± 10 KU of the manufacturer's original certification.

912.04 ORGANIC ZINC RICH PRIMERS. The following additional requirements shall apply:

TEST PROPERTY	SPECIFICATION LIMITS
Pot Life, hr min	8
X-ray Pigment	match original
Dry Time - touch - hard	<30 minutes <24 hr
I.R. Vehicle	match original
Zinc Content, dry film, % min	85

912.05 GRAY ALKYD. Gray alkyd paint shall consist of 45 ± 2 percent pigment and 55 ± 2 percent vehicle. The pigment shall not have less than 22 percent rutile titanium dioxide and 3 percent zinc dioxide. The vehicle shall have 50 ± 2 percent alkyd resin, conforming to Federal Specification TT-R-266, Type II, Class A or B.

The gray alkyd paint shall also conform to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Unit Weight, lb/gal (kg/l) min	10.7 (1.28)
Viscosity, KU	70 - 80
Drying Time - set to touch, hr max - recoating, hr max	2.5 18.0
Color	Medium Gray
Gloss	Dull
Flexibility, Federal Spec TT-P-25	Shall not crack

912.06 ALKYD FINISH COAT ENAMELS. Alkyd finish coat enamels shall conform to Federal Specification TT-E-529, Composition G, Table II, except that gloss requirements will be deleted and the viscosity shall be 67 to 87 KU. Any color not specified in Table II shall conform to the following requirements:

TEST PROPERTY	SPECIFICATION LIMITS
Total Solids, % by weight of paint min	62
Pigment Solids, % by weight of paint	36-40
Vehicle Solids, % by weight of paint min	23
Extender Pigment, % by weight of paint max	55
Contrast Ratio	0.98

912.07 VINYL INTERMEDIATE AND FINISH COATS. Vinyl intermediate and finish coats shall conform to SSPC-Paint 9 or as specified by the manufacturer of the inorganic primer. Vehicle solid tolerance shall be ± 1 percent. Drying time to touch and hard shall not be more than 15 minutes and 30 minutes respectively.

912.08 LUSTERLESS RUST COLOR FINISH COAT. Lusterless rust color finish coat for weathering steel shall conform to Federal Specification TT-E-527.

912.09 EPOXY-POLYAMIDE INTERMEDIATE COAT. The fineness of grind shall be 3.0 minimum (Hegman Units). Drying time to touch and hard shall be the minimum recommended by the paint manufacturer. Solids by volume shall be 49 percent minimum.

912.10 ALIPHATIC URETHANE FINISH COAT. Drying time to touch and hard shall be the minimum recommended by the paint manufacturer. Solids by volume shall be 47 percent minimum.

912.11 ALUMINUM ALKYD. Aluminum alkyd paint shall conform to SSPC-Paint 101, Type I, leafing or Type II, nonleafing, as specified in the Contract Documents.

912.12 ALUMINUM VINYL. Aluminum vinyl paint shall conform to SSPC-Paint 8.

912.13 ALUMINUM EPOXY MASTIC PAINT. Drying time to touch and hard shall not be less than 24 and 48 hours, respectively. Pot life shall not be less than three hours. Volume of solids shall be a minimum of 85 percent.

912.14 EQUIPMENT ENAMEL. Equipment enamel shall conform to Federal Specification TT-E-489, enamel alkyd for exterior and interior surfaces. Colors shall conform to the following:

COLOR	FEDERAL SPECIFICATION NUMBER
Black	17038
Yellow	13538
Gray	16187
Red	11105

912.15 WATERBORNE ACRYLIC PAINT FOR CONCRETE TRAFFIC BARRIERS. Waterborne acrylic paint for concrete traffic barriers shall conform to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Weight in lb/gal (kg/l)	Original Sample
Solids by Weight, % min	56
Dry Opacity Contrast Ratio 0.005 in. (0.13 mm) wet film, min	0.98
Infrared Spectrogram	Original Sample
Freeze-Thaw Resistance, Parabolic Dish Surface, C 672, Modified Ratings	0 - Rating @ 100 cycles
Color	Federal Standard 595 White No. 17875

Control and acceptance of the paint will be based on the following limits:

TEST PROPERTY	SPECIFICATION LIMITS
Weight in lb/gal (kg/l)	±0.2 (0.02)
Infrared Spectrogram	Match Original

912.16 Paint Systems.

PAINT	COAT	SECTION	DRY FILM THICKNESS, mils (mm)	USAGE
SYSTEM A				
Inorganic Zinc	I	912.03	3.0 min-5.0 max (0.08 - 0.13)	Shop Primer
Vinyl	II	912.07	1.0 min - 1.5 max (0.03 - 0.04)	*Tie Coat
Vinyl	III	912.07	4.0 (0.10) min	Finish Coat
SYSTEM B				
Aluminum Epoxy Mastic	I	912.13	5.0 min-8.0 max (0.13-0.20)	Primer/First Cover-All Coat
Aluminum Epoxy Mastic	II	912.13	5.0 min-8.0 max (0.13-0.20)	*Second Cover-All Coat
Urethane	III	912.10	2.0 min-3.0 max (0.05-0.08)	Finish Coat
SYSTEM C				
Organic Zinc	I	912.04	3.0 min - 5.0 max (0.08 - 0.13)	Primer/First Cover-All Coat
Epoxy Mastic	II	912.09	5.0 (0.13) min	*Second Cover-All Coat
Urethane	III	912.10	2.0 (0.05) min	*Finish Coat
SYSTEM D				
Alkyd	I	912.02	2.0 (0.05) min	Bare Metal Primer
Alkyd	II	912.02	2.0 (0.05) min	*First Cover-All Coat
Alkyd	III	912.05	2.0 (0.05) min	*Second Cover-All Coat
Alkyd	IV	912.06	2.0 (0.05) min	Finish Coat
SYSTEM E				
Organic Zinc Rich	I	912.04	2.0 (0.05) min	Primer/First Cover-All Coat
Aluminum Alkyd	II	912.11	2.0 (0.05) min	*Second Cover-All Coat
Aluminum Alkyd	III	912.11	2.0 (0.05) min	Finish Coat

NOTE: * Shall be tinted to differentiate between coats.

SECTION 913 - WATERPROOFING

913.01 ASPHALT FOR DAMPPROOFING AND WATERPROOFING. The asphalt shall conform to M 115.

913.02 PRIMER FOR USE WITH ASPHALT FOR DAMPPROOFING AND WATERPROOFING. The primer shall conform to M 116.

913.03 FABRIC SATURATED WITH ASPHALT FOR USE IN WATERPROOFING. The fabric shall conform to M 117.

913.04 SHEET METAL FOR FLASHING. Sheet metal for flashing shall be of a material and gauge as specified in the Contract Documents.

913.04.01 Copper. Copper shall conform to the weight per square foot and gauge requirements of B 152.

913.04.02 Galvanized Sheets. Galvanized sheets shall conform to A 525, Coating Designation G 90.

SECTION 914 - CHAIN LINK FENCE

914.00 CERTIFICATION. The manufacturer shall furnish certification as specified in TC-1.02. In addition, a sample of the fence fabric shall be submitted with the fabric certification.

914.01 CHAIN LINK FENCING FABRIC. Chain link fencing fabric shall be 2 in. (50 mm) mesh woven from coated No. 6 gauge (4.877 mm) wire for 6 ft and 8 ft fence and No. 9 gauge (3.767 mm) wire for 5 ft fence unless otherwise specified in the Contract Documents. The ends shall have a knuckled selvage at the bottom and a barbed selvage at the top. The fabric shall conform to M 181. Type I fabric shall conform to Class D coating. Vinyl coated steel shall conform to F 668, Class 2B thermally fused. Vinyl color shall be warm gray or black as specified in the Contract Documents.

914.02 TIE WIRES, LINE POST CLIPS, TENSION WIRES AND TENSION WIRE CLIPS. These items shall conform to M 181. The galvanized coating shall weigh a minimum of 1.2 oz/ft² (0.366 kg/m²). These items, when used with aluminum coated steel fabric, shall be coated with aluminum at a minimum weight of 0.40 oz/ft² (0.122 kg/m²). The tension wire used with polyvinyl chloride (PVC) coated steel fabric shall have the same coating thickness and color requirement as the fence fabric.

914.03 POSTS, BRACES, FITTINGS AND HARDWARE. All posts, braces, fittings and hardware shall conform to M 181. When these items are specified to be PVC coated, they shall be thermally fused and bonded. The PVC thickness shall be 10 to 15 mil (0.25 to 0.38 mm) except that bolts, nuts, and washers shall be metallic coated steel.

When opting to use round posts, the posts shall conform to industry standards for Class 1 or 2.

914.04 GATES. The fabric used for gates shall be identical to the fencing fabric. The gate frame and other hardware shall conform to 914.02 and 914.03. When the gate frame is PVC coated, movable fittings, such as hinges and latches, shall be field coated with a PVC coating specifically prepared for this purpose.

914.05 BARBED WIRE. Barbed wire shall conform to A 121. The barbed wire shall be 12½ gauge (2.502 mm) with four point, round barbs at 5 in. (125 mm) spacings and Class 3 coating requirements.

SECTION 915 - PRODUCTION PLANTS

915.01 GENERAL. These specifications are applicable to all batching and proportioning plants.

915.01.01 Approval. The plant from which the Contractor proposes to obtain material will be approved by the Regional Engineer before starting deliveries.

915.01.02 Lead Time. The Contractor shall notify the Regional Engineer at least two working days prior to the start of operations. The Regional Engineer or his representative shall be kept informed of plant operational procedures and notified when a change is planned. Inspectors shall have safe access to all areas of the plant for the performance of their duties. All equipment, tools, machinery and parts of the plant shall be maintained in a satisfactory working condition at all times.

915.01.03 Storage. The storage and handling of aggregates in stockpiles and bins shall be done in a manner that will prevent segregation, intermingling and contamination by foreign material or equipment. Bins discharging to feeder systems shall be equipped with accessible calibrated devices to vary the quantity of material being fed.

915.01.04 Measuring Devices. Measuring devices shall conform to the current edition of the National Institute of Standards and Technology Handbook 44, except as modified by Table 915. The producer shall be responsible for providing all personnel and equipment for calibrating measuring devices.

Before any proportioning plant starts operation, and at least once each year thereafter, all measuring devices, meters, dispensers, test weights and other measuring devices shall be inspected, tested and certified to be in proper operating condition by competent testing agencies approved by the Engineer. During the period of operation, all measuring devices, meters, dispensers and other measuring devices shall be tested monthly and certified for accuracy and operating condition by the producer or an approved testing agency. Any weighing device by which materials are sold by weight as a basis of payment shall be tested monthly and certified by an approved testing agency. The Engineer shall be notified at least two working days in advance of monthly scale inspections. The certifications shall state capacities, minimum graduations, loads applied, degree of accuracy and magnitude.

Balance and zero conditions of scales shall be checked daily, and at any other time requested by the Regional Engineer or his representative. The Engineer may, at any time, direct that any measuring device be tested by the

producer or an outside agency if there is any doubt about the accuracy of such measuring device. Certificates of inspection shall be posted in a prominent place in the plant, and a copy shall be promptly submitted to the Engineer.

Production plant tolerances shall conform to the following table:

TABLE 915

MATERIAL	*MAINTENANCE TOLERANCE	UNIT OF MEASURE
Aggregate	0.2%	Weight
Portland Cement or Blended Hydraulic Cement of Ground Iron Blast Furnace Slag or Fly Ash	0.2%	Weight
Asphalt	0.2%	Weight or Volume
Water	1.5%	Weight or Volume
Additives	0.5%	Weight or Volume

*Maintenance tolerance shall be the specified percent of the total capacity of the scale or the smallest scale graduation, whichever is greater.

If during the monthly check, the measuring devices are found to deviate from the allowable tolerance, they shall be suspended from use until recalibrated to the Specification requirements. A price adjustment will apply to materials sold and accepted by weight that are supplied during the measuring device malfunction period when the malfunction resulted in an overpayment. The measuring device malfunction period is defined as the elapsed time between the two successive monthly checks.

915.01.05 Sampling Equipment. The producer shall provide all personnel and equipment for obtaining samples from the last practical point prior to combination with other ingredients or introduction into the mixer. Sampling

shall conform to Tables 1-1 and 2-1 of the MSMT Field Procedures Manual. The sampling equipment shall have a minimum capacity of 30 lb (14 kg) and shall be positioned in a manner that will provide an accurate representation of the material being furnished. When the size of the sample is too large to be transported, approved sample splitting devices shall be available at the point of sampling that will split the sample to no more than twice the proper testing size.

915.01.06 Plant Laboratory. The producer shall provide, at proportioning or batching plants, quarters suitable for housing and using the equipment necessary for conducting the various tests required. These quarters shall be for the exclusive use of the Engineers and Inspectors for testing and recording purposes. When practical, the quarters shall be adjacent to or within 300 ft (90 m) of the plant operator's location. The plant laboratory shall conform to all provisions specified on Standard No. MD-103.02, 103.05 and 103.06 or a substitute, approved by the Engineer. Items 1(c), (d) and (1) as specified on Standard No. MD-103.05 through 103.06 are excluded.

915.02 HOT MIX ASPHALT (HMA) PLANTS. All plants shall conform to M 156 except as modified in 915.01 and the following:

- (a) **Dryer.** The fuel used for drying aggregates shall be compatible with the plant manufacturer's recommendations.
- (b) **Hot Aggregate Bins.** Existing plants shall be equipped with alarms. New plants shall conform to M 156.
- (c) **Mixer Unit for Batch Method.** Minimum dry and wet mixing times shall be 5 seconds and 15 seconds, respectively.
- (d) Control testing for asphalt content shall be performed by the producer in conformance with MSMT 419.
- (e) Truck scale weighing shall conform to the National Institute for Standards and Technology (NIST), except as follows:

- (1) A written plant summary shall be kept by the producer showing the Contract number, truck identification (I.D.) number, type material being produced, the number of truck loads, and the total tons of mix.
 - (2) The producer shall supply a delivery ticket with the I.D. number, Contract number, date, truck I.D. number, time loaded, gross and tare weights and net weight of the mix for each load. When requested by the Engineer, the temperature of the mix shall also be shown on the delivery ticket.
- (f) **Automatic Weighing and Printout.** The producer may use an approved plant automatic weighing and printout system. A printed delivery ticket for each load shall be provided with the cumulative total weighed into the truck, Contract number, time loaded, I.D. of the type of mix and net weight of mix. When requested by the Engineer, the temperature of the mix shall also be shown on the delivery ticket. The temperature may be handwritten on the delivery ticket.
- (g) **Hauling Units.** The mixture shall be transported to the work site in units previously cleaned of all foreign material and the contents of each load completely covered with suitable material of sufficient size to protect it from the weather. Each unit shall have convenient access from ground level to insert thermometers to determine mix temperature.

The inside surface of all hauling units shall be treated with an approved release agent that will not contaminate or alter the characteristics of the mixture. Petroleum derivatives shall not be used. Approval will be based on results from tests performed in conformance with MSMT 414.

- (h) Drum mixer plants shall be calibrated in conformance with MSMT 453 and approved by the Engineer. A monitoring station for the purpose of controlling the entire operation shall be provided. If any part of this control system fails, an alternative control system approved by the Engineer may be used for a maximum of two working days.

The producer shall determine the moisture content of all aggregates in conformance with MSMT 251.

915.03 PORTLAND CEMENT CONCRETE PLANTS. Portland cement concrete plants shall conform to M 157 except as modified herein, including the applicable requirements of 915.01.

915.03.01 Storage of Aggregate. Coarse and fine aggregate for use in portland cement concrete shall be maintained at a uniform moisture content in excess of its saturated surface dry condition. Water added for this purpose shall conform to 921.01.

915.03.02 Temperature of Water and Cement. The plant shall be equipped with methods of heating or cooling the mix as approved by the Engineer. The temperature of the plastic concrete shall conform to 902.10.03. The temperature of the cementitious materials and the mixing water at the time they are to be used in the mix shall not exceed 170 F (77 C).

915.03.03 Load Tickets. The producer shall issue a completed Administration Form 116 in duplicate for each load. Distribution shall be made as specified in 915.03.05(c)(2). The producer's copy shall be readily available for inspection upon request by the Regional Engineer or his representative. Computer generated printouts may be used in lieu of the Administration's Load Ticket when approved by the Regional Engineer.

915.03.04 Mixers and Agitators. The requirements for mixers and agitators and for mixing and delivery of ready mixed concrete shall conform to M 157 with the following exceptions:

- (a) Mixing during transit will not be permitted. Drums shall be operated at agitating speed only.
 - (1) The main proportion and volume of mixing water shall be added at the plant through the certified plant water meter.
 - (2) A maximum of 3 gallons (11.4 liters) of water per cubic yard of concrete may be added at the job site provided the maximum specified water/cement ratio is not exceeded.

- (3) No water shall be added after partial discharge of load.
- (b) No mixer or agitator containing wash water in the drum shall be loaded.
- (c) When the concrete is specified or permitted to be made by volumetric batching and continuous mixing, the batching and mixing unit shall conform to C 685. Calibration shall conform to MSMT 558.

Where no mixer performance tests are made for stationary mixers, the minimum mixing time shall be 75 seconds.

915.03.05 Certified Concrete Plant. The producer shall be responsible for quality control of plant operations to assure that the material conforms to Specification requirements. The quality control process will be subject to unannounced periodic inspection by representatives of the Regional Engineer. Full participation in the inspection by the plant's certified technician will be required.

Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specification requirements. The Administration will accept certification by a registered Maryland professional engineer that the plant facilities conform to all applicable Specification requirements. However, final acceptance will be determined by the Administration.

Responsibilities of the Concrete Producer.

- (a) The producer shall notify the Regional Engineer one working day prior to producing materials for Administration projects.
- (b) Quality Control. All producers supplying concrete shall have the certified concrete plant technician present while concrete is being batched and delivered to the project. This technician shall supervise concrete production.

- (1) Control tests shall be performed by the certified concrete plant technician. This technician shall perform moisture tests, adjust proportions of aggregate for free moisture, complete and sign batch or approved delivery tickets, and assure quality control of the batching operations.
 - (2) Technician certification will be awarded upon satisfactory completion of examinations administered by the Administration in conformance with MSMT 560.
 - (3) The producer shall supply all necessary test equipment.
 - (4) Sample frequency shall conform to the MSMT Frequency Guide, Table 1-1.
- (c) Reports. The following reports will be processed by the producer:
- (1) Administration Form 113, daily, stating that the material was sampled and tested in conformance with the Administration's sampling and testing guidelines and complies with the applicable Specifications. Distribution to producer's file and Regional Laboratory.
 - (2) Administration Form 116, for each load. Distribution to project and producer's file.
 - (3) Administration Forms for all concrete materials sampled at the plant in conformance with MSMT Frequency Guide Table 1-1.
 - (4) Test Worksheet, daily - for all tests performed at the plant.
 - (5) Quality Assurance Plant Checklist (QAPC) daily. Distribution to producer's file and Regional Laboratory.

Responsibilities of the Administration.

(a) Comprehensive Inspection.

(b) Acceptance Inspection and Testing.

(1) If deficiencies, as described in the QAPC are found during an Administration inspection, the producer will be notified immediately to correct the deficiencies to the satisfaction of the Engineer. Production will be suspended for critical deficiencies.

(2) If consecutive inspections reveal identical deficiencies, or if accumulated deficiencies exceed the critical value defined on the QAPC, the producer will be notified that a reinspection will be held in two production days. All deficiencies shall be corrected by the reinspection date.

(3) If reinspection fails, the Regional Engineer will assign an Inspector to monitor plant operations for a maximum of five Administration production days. If at the end of this period the quality control process is not satisfactory, plant approval will be rescinded and the plant shall be recertified before Administration production will be continued.

(4) Recertification of Concrete Plant. Documentation of corrective action shall be submitted to the Regional Engineer by a registered Maryland professional engineer. When this documentation is approved by the Engineer, a comprehensive inspection will be conducted to recertify the concrete plant.

(c) Independent Assurance Sampling and Testing (IAST) Inspection.

(d) Technician Certification. In conformance with MSMT 560.

915.04 STABILIZED BASE COURSE PLANTS. In addition to 915.01, the following shall apply to stabilized base course plants.

Mechanical mixers shall be used, as approved by the Engineer. All plants shall be equipped with automatic cutoff devices interlocked so the plant will stop operating if delivery of any component of the mix fails.

The amount of stabilization shall be determined in conformance with MSMT 254.

The charge in a batch mixer, or rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all materials. Mixes stabilized with water or water and calcium chloride shall be placed within 72 hours after mixing. Frozen aggregates shall not be used.

Mixed materials shall be handled and transported in a manner that will minimize segregation and loss of moisture or volatiles. All loads shall be covered in conformance with State laws unless hauling is off road and approved by the Engineer.

When cement is used as a stabilizing agent, the amount of water added at the plant shall be controlled to obtain a uniform mixture that conforms to the required density.

When emulsified asphalt is used as a stabilizing agent, all aggregate shall contain moisture in excess of the saturated surface dry condition at time of mixing.

915.04.01 Certified Base Course Plants. The quality control and condition of all materials used in base courses, as well as all necessary adjustments required in using the materials, shall be the responsibility of the base course producer. The quality assurance process will be subject to unannounced periodic inspection by representatives of the Regional Engineer when Administration projects are in progress. The plant's certified technician shall participate in the inspection.

Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specification requirements. The Administration will accept certification by a registered Maryland professional engineer that the plant facilities conform to all applicable Specification requirements. However, final acceptance will be determined by the Administration.

Responsibilities of the Base Course Producer.

(a) The producer shall notify the Regional Engineer one working day prior to producing materials for Administration projects.

(b) **Quality Control.** The producer shall be responsible for quality control of plant operations to assure that the material conforms to Specification requirements. All producers supplying base courses shall have a certified base course plant technician present while base course material is being plant mixed and delivered to the project. This technician shall supervise base course production.

(1) Control tests shall be performed by a certified base course plant technician. This technician shall obtain samples and test in conformance with MSMT Frequency Guide Table 1-1 and 2-1.

(2) Technician certification will be awarded upon satisfactory completion of an examination given by the Administration in conformance with MSMT 562. The certification shall be as follows:

Applications for certification shall be obtained from the Regional Engineer a minimum of 30 days prior to producing material for the Administration.

The Regional Engineer will contact the producer and schedule an examination based on AASHTO and MSMT field procedures and knowledge of the Administration's base course plant reports and documentation.

Upon satisfactory completion of the examination, a certificate will be issued.

(3) The producer shall supply all necessary test equipment. In addition, the producer shall provide onsite facilities suitable for conducting the required tests. Offsite test facilities shall require approval of the Regional Engineer.

(c) Reports. The following reports shall be processed by the producer:

- (1) MD SHA Form 43, daily, stating that the material was sampled and tested in conformance with SHA's sampling and testing guidelines and conforms to the applicable SHA Specifications. Distribution to producer's file and Regional Laboratory.
- (2) MD SHA Form 88, for all additives introduced at the plant, frequency in conformance with Table 2-1. Distribution to Regional Laboratory and producer's file.
- (3) Daily Plant Certification Form showing that a technician was on duty at the plant. Distribution to project and producer's file.
- (4) Test Worksheet, daily - for all tests performed at the plant.
- (5) Base course plant checklist daily. Distribution to producer's file.

Responsibilities of the Administration.

(a) Comprehensive Inspection.

(b) Acceptance Inspection and Testing.

- (1) If deficiencies are found, as defined in the base course plant checklist during an acceptance inspection, the producer will be notified immediately and operations shall be suspended if corrections are not made to the satisfaction of the Engineer.
- (2) If on consecutive inspections identical deficiencies are found, the producer will be notified that a reinspection will be held in two Administration production days. All deficiencies shall be corrected by the reinspection date. The Regional Engineer will determine whether plant certification will be revoked.

(c) Independent Assurance Sampling and Testing (IAST) Inspection.

(d) Recertification of Aggregate Base Course Plant. Documentation of corrective action shall be submitted by a registered Maryland professional engineer. When this documentation is approved, a comprehensive inspection will be conducted to recertify the base course plant.

(e) Technician Certification. In conformance with MSMT 562.

915.05 SOIL-CEMENT PLANTS. The plant shall be capable of maintaining the following flow tolerances:

- ± 5 percent of the specified cement quantity,
- ±10 percent of the specified soil quantity, and
- ±10 percent of the specified water quantity.

SECTION 916— SOIL AND SOIL-AGGREGATE BORROW

916.01 BORROW EXCAVATION. All borrow excavation shall be a soil or soil aggregate mixture and shall conform to the following:

Maximum dry density and optimum moisture content of the material shall be determined as specified in T 180, Method C unless the material has more than 35 percent retained on the No. 4 sieve, in which case Method D shall be used. Material with a maximum dry density of less than 100 lb/ft³ (1600 kg/m³) is unsatisfactory and shall not be used in embankments unless otherwise specified in the Contract Documents.

Recycled portland cement concrete or HMA pavement may be used as select borrow, capping borrow and modified borrow with the written approval of the Engineer.

916.01.01 Select Borrow. Select borrow shall conform to A-2, A-3 or A-2-4 material as specified in the Contract Documents. The maximum dry density shall not be less than 105 lb/ft³ (1680 kg/m³).

916.01.02 Capping Borrow. Capping borrow shall conform to the Select

Borrow requirements except when A-3 material has less than 10 percent retained on the No. 10 sieve, at least 15 percent shall pass the No. 200 sieve. Sieve analysis shall be determined in conformance with MSMT 302.

916.01.03 Modified Borrow. Modified borrow shall have a minimum of 25 percent retained on the No. 10 sieve, a liquid limit not greater than 30 when tested as specified in T 89, and a plasticity index not greater than 9 when tested as specified in T 90. The maximum dry density shall not be less than 115 lb/ft³ (1840 kg/m³). A-5 material, as defined in the Contract Documents shall not be used.

916.01.04 Common Borrow. Common borrow shall have a maximum dry density of not less than 100 lb/ft³ (1600 kg/m³).

SECTION 917 — EPOXY PROTECTIVE COATINGS

917.01 EPOXY PROTECTIVE COATINGS FOR CONCRETE. The protective coatings shall be two component epoxy systems for use in conjunction with concrete. One component shall be a clear or pigmented condensation product of the reaction of epichlorohydrin with bisphenol A, the resin of which shall be composed of 100 percent reactive constituents. The other component shall be a clear polyamide hardener.

The producer shall submit a sample of each component for laboratory analysis. The sample shall be coded as the original sample. The original and all subsequent samples shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Pot Life, hr min	Fed. Spec TT-C-535	8
Color	Fed. Standard 595	White No. 27875 Gray No. 26440
Dry Film Thickness 1st coat, mil (mm) min 2nd coat, mil (mm) min	D 1005	2 (0.05) 3 (0.08)
Sagging	MSMT 616	Must pass test for recommended film thickness
Flexibility	Federal Spec TT-P-115	Must not crack, check or delaminate
Infrared Spectrogram	Equipment Manufacturer's Procedure	Each component must match original sample
Tensile Strength, psi (MPa) min	MSMT 609	400 (2.8)

917.02 FUSION BONDED EPOXY POWDER COATINGS FOR STEEL. This work shall consist of furnishing and applying an electrostatically applied fusion bonded epoxy on metal surfaces as specified in the Contract Documents. Epoxy protective coatings shall be a one coat, heat curable, thermosetting powdered coating. Unless otherwise specified in the Contract Documents, the color for structural steel shall match Federal Standard No. 595, No. 20040. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the prequalified materials list maintained by the Office of Materials and Research.

Epoxy coatings for reinforcement steel shall conform to M 284 with the following exceptions:

- (a) The chemical resistance requirements shall include testing in 7 percent NaCl and 3M NaCl aqueous solutions.
- (b) The holiday requirement shall be waived.
- (c) The coating thickness shall be 7 ± 2 mil (0.18 ± 0.05 mm) after cure.

917.02.01 Touch Up System. Material used for the touch up system shall be a two part epoxy system designated and color matched for patching the epoxy coating used.

Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one hour after application at 35 F (1.8 C) ambient.

917.02.02 Certification. The manufacturer shall furnish certification as specified in TC-1.02.

917.03 FUSION BONDED POLYESTER COATING FOR METAL TRAFFIC BARRIERS.

917.03.01 Cleaning and Coating. Cleaning and coating shall be performed in an environmentally controlled plant that is fully enclosed and preapproved by the Administration.

All components shall be free of any oil or grease and shall be grit blasted to near white SSPC-SP 10 using steel grit #40, steel shot #390 or a mixture of both. Cleaned surfaces shall be protected from high humidity, rainfall or surface moisture and shall not be allowed to flash rust. Blast profile shall be approximately 1 to 1.5 mil (0.03 to 0.04 mm), but not greater than 2 mil (0.05 mm), as checked with a surface profile gauge approved by the Engineer.

The polyester coating shall be checked for continuity using a 67½ volt wet sponge detector to check for holidays, pinholes and discontinuities. Coating thickness shall be checked with a properly calibrated magnetic gauge. Minor defects shall be repaired with a liquid touch up recommended by the manufacturer.

The polyester coating shall conform to the following additional requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Abrasion	Taber Abraser CS-10, 1000 gm load, 1000 cycles, D 1044	100 mg max weight loss
Adhesion	D 3359, Initial & 1000 hr, Method A	Rating 5A
Gloss	D 523, Initial 500 hr 1000 hr	82% @ 60 deg. 90% @ 60 deg.
Hardness	D 3363	2H - No Gauge
Impact	D 2794	Pass 80 in.-lb (90 N x m)
Salt Spray Resistance	B 117, D 1654 1000 hr unscribed 400 hr scribed	Table 2, Rating 10 Table 2, Rating 10
Weather Resistance	G 23, 102 minutes of light followed by 18 minutes of light & Water Spray as in Method I.	No film failure
Thickness	G 12	6 ±2 mil (0.15 ±0.05 mm)
Color	Federal Standard 595	Color No. 20040
Infrared Spectrogram	Equipment Manufacturer's Procedure	Match original
Flexibility	1/4 in. Mandrel 180 ° bend in 1 second, cured per manufacturer's recommendations or specimen prepared by manufacturer.	No breaks, flaking or cracks. Tested with a Q-panel with no cracking.
Humidity	D 2247, 1000 hr	No blistering.

917.03.02 Certification. The manufacturer shall furnish certification as specified in TC-1.02.

SECTION 918 - TRAFFIC BARRIERS

918.00 CERTIFICATION. The manufacturer shall furnish certification as specified in TC-1.02.

918.01 TRAFFIC BARRIER W BEAM. Rail elements and end treatments shall conform to M 180, Type II or IV. In lieu of galvanizing, rail elements may be coated with a minimum of 5 mil (0.13 mm) dry film thickness of inorganic zinc rich primer conforming to 912.03. The primer shall be applied as specified by the manufacturer after the rail elements are fabricated.

918.02 TRAFFIC BARRIER POSTS. Posts shall conform to M 183 for steel and M 111 for galvanized coating. In lieu of galvanizing, posts may be coated with a minimum of 5 mil (0.13 mm) dry film thickness of inorganic zinc rich primer conforming to 912.03. The primer shall be applied as specified by the manufacturer after the posts are fabricated.

918.03 HARDWARE FOR TRAFFIC BARRIERS. Hardware for traffic barriers shall conform to M 183 for quality of steel and M 232 for galvanized coating.

918.04 TIMBER RAIL AND POSTS. Timber rail and posts shall conform to M 168.

918.05 WIRE ROPE. Wire rope shall conform to Federal Specification RR-W-410, Type I, General Purpose, Class 2, 6 by 19, improved plow steel, fiber core. The individual wire strands shall have a zinc coating of 0.8 oz/ft² (240 g/m²) when tested as specified in T 65.

SECTION 919 - RESERVED

SECTION 920 - LANDSCAPING

920.01 TOPSOIL.

920.01.01 Salvaged Topsoil. Salvaged topsoil shall be that surface material to be salvaged from the project which has been classified as topsoil as specified in the Contract Documents.

920.01.02 Furnished Topsoil. Furnished topsoil shall be natural, friable surface soil uniform in color and texture and not supplied from the project. Topsoil shall be free from any parts of Johnsongrass, Canada Thistle, or Phragmites.

Topsoil shall have an organic content between 1.5 - 10.0 percent by weight when tested as specified in T 194. Furnished topsoil shall have a corrected pH value of not less than 6.0 nor more than 7.5.

Grading analysis shall be as follows:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
50.00 mm (2 in.)	100
4.75 mm (No. 4)	90
2.00 mm (No. 10)	80

Topsoil shall be analyzed for sand, silt, and clay as specified in T 88.

Textural analysis shall be as follows:

SOIL PARTICLE SIZES	PERCENT PASSING BY WEIGHT
Sand (2.0 - 0.050 mm)	20 - 75
Silt (0.050 - 0.002 mm)	10 - 60
Clay (less than 0.002 mm)	5 - 30

920.02 AGRICULTURAL LIMESTONE. Limestone shall contain not less than 85 percent calcium and magnesium carbonates. Dolomitic (magnesium) limestone shall contain at least 10 percent magnesium as magnesium oxide and 85 percent calcium and magnesium carbonates. Limestone shall conform to the following gradation:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
2.00 mm (No. 10)	100
0.850 mm (No. 20)	98
0.150 mm (No. 100)	50

920.03 FERTILIZER.

920.03.01 Granular and Liquid Fertilizer. Fertilizer shall be commercial grade conforming to all State and Federal regulations and the Standards of the Association of Official Analytical Chemists Standard analyses shall be: 0-20-20, 5-20-20, 10-10-10, 10-20-10, 10-22-22 (50% nitrogen from 38-0-0 ureaform), 20-20-20 and 38-0-0 (ureaform). All analyses are subject to approval by the Engineer prior to application.

920.03.02 Fertilizer Packets. Fertilizer shall be contained in a slow release polyethylene perforated bag with micropore holes for controlled feeding. The bag shall contain 4 oz (110 g) of water soluble fertilizer, analysis 16-8-16 to be effective for approximately eight years. Minimum guaranteed analysis of the packets shall be as follows:

MINIMUM ANALYSIS	
Total Nitrogen (N) 16%	9% Ammoniacal Nitrogen (NH ₃ N) 7% Nitrate Nitrogen (NO ₃ N)
Available Phosphoric Acid (P ₂ O ₅)	8% from Ammonium Phosphate (NH ₄ PO ₄)
Soluble Potash (K ₂ O)	16% from Potassium Chloride (KCl)
Potential Acidity equivalent to 850 lb Calcium Carbonate (CaCO ₃) per ton.	

920.03.03 Fertilizer Tablets. Fertilizer tablets shall consist of a minimum 21 gram tablet containing a slow release (2 year) fertil-izer, analysis 20-10-5.

Minimum guaranteed analysis of the tablets shall be as follows:

MINIMUM TABLET ANALYSIS	
Total Nitrogen (N) 20%	7% Water Soluble Organic Nitrogen 13% Water Insoluble Organic Nitrogen
Available Phosphoric Acid (P ₂ O ₅)	10%
Soluble Potash (K ₂ O)	5%

920.03.04 Iron Sulfate. Iron sulfate shall be an approved horticultural product produced as a fertilizer for supplying iron and as a soil acidifier.

920.04 SEED, SEED MIXES, AND SOD.

All seed and seed mixes shall be free from Maryland prohibited noxious weed seeds and the following:

- | | |
|------------------|---------------|
| Annual Bluegrass | Giant Foxtail |
| Bermudagrass | Horse Nettle |
| Bindweed | Spurred Anoda |
| Cocklebur | Wild Garlic |
| Corn Cockle | Wild Onion |
| Dodder | |

920.04.01 Seed. Seed will be sampled and tested by an inspector from the Turf and Seed Section, Maryland Department of Agriculture (MDA), Annapolis, Maryland. All seed containers shall be tagged with a MDA supervised mix program seed tag. Seed shall comply with the Maryland Seed Law, Agricultural Article of the Annotated Code of Maryland. The authority for seed names shall be the current printing of USDA, Agriculture 505 Handbook.

Grass and legume seeds shall conform to the latest construction directives regarding cultivars and varieties and the following:

SEED	PURITY NOT LESS THAN %	WEED SEED NOT MORE THAN %	MINIMUM GERMINATION (including hard seed) %	HARD SEED NOT TO EXCEED %
Kentucky Bluegrass (<i>Poa pratensis</i>)	90	0.4	80	-
Canada Bluegrass (<i>Poa compressa</i>)	90	0.5	80	-
Redtop (<i>Agrostis gigantea</i>)	92	0.7	80	-
Lehmann's Lovegrass (<i>Eragrostis lehmanniana</i>)	98	0.5	80	-
Foxtail Millet (<i>Setaria italica</i>)	99	0.1	80	-
Hard Fescue (<i>Festuca longifolia</i>)	98	0.5	85	-
Tall Fescue (<i>Festuca arundinacea</i>)	98	0.5	90	-
Chewings Fescue (<i>Festuca rubra commutata</i>)	98	0.5	85	-
Oats (<i>Avena sativa</i>)	99	0.5	90	-
Crownvetch (<i>Coronilla varia</i>)	98	0.5	80	30
Serecia Lespedeza (<i>Lespedeza cuneata</i>)	98	0.5	85	20
Birdsfoot Trefoil (<i>Lotus corniculatus</i>)	97	0.7	85	20
Weeping Lovegrass (<i>Eragrostis curvula</i>)	98	0.5	80	-
Barley (<i>Hordeum vulgare</i>)	98	0.3	90	-
Rye Grain (<i>Secale cereale</i>)	98	0.1	85	-
Creeping Red Fescue (<i>Festuca rubra</i>)	98	0.5	85	-
Sheep Fescue (<i>Festuca ovina</i>)	98	0.5	85	-

920.04.02 Seed Mixes. The Contractor or seed supplier shall notify the Turf and Seed Section, Maryland Department of Agriculture, Annapolis, Maryland, at least 10 days prior to the mixing date as to the hour, date, and location of the mixing operation. The Contractor or seed supplier shall assume charges for seed inspections and seed testing service. Seed mixes shall conform to the following:

(a) Seed Mix No. 1

- 75 % Tall Fescue (Certified Seed Only)
- 5 % Redtop
- 10 % Canada Bluegrass
- 10 % Kentucky Bluegrass (Certified Seed Only)

(b) Seed Mix No. 2

- 50 % Kentucky Bluegrass (Certified Seed Only)
- 40 % Fine (Chewings, Creeping Red, Hard, Sheep) Fescue (Certified Seed Only)
- 10 % Redtop

(c) Temporary Seed Mix

- 95 % Barley or Rye
- 5 % Foxtail Millet

(d) Cover Companion Seed Mix. Cover Companion Seed Mix for use with Woody Shrub Seed Mix shall conform to 705.01.01 Regional Areas.

REGION 1

- 35 % Tall Fescue
- 35 % Canada Bluegrass
- 15 % Redtop
- 15 % Birdsfoot trefoil (inoculant required)

REGIONS 2A, 2B, & 3

- 30 % Chewings Fescue
- 30 % Canada Bluegrass
- 10 % Redtop
- 30 % Serecia Lespedeza (inoculant required)

(e) Woody Shrub Seed Mix

REGIONS 1, 2A, 2B, & 3

- 25 % Amur Honeysuckle (*Lonicera maackii*) or
Tatarian Honeysuckle (*Lonicera tatarica*)
- 20 % Bristly Locust (*Robina fertilis*)(inoculant required)
- 25 % Shrub Lespedeza(*Lespedeza bicolor*)(inoculant required)
- 30 % Arrowwood Viburnum (*Viburnum dentatum*)

The woody shrub seed mix shall have a minimum purity of 98 percent.

(f) Wildflower Seed Mix

REGIONS 1, 2A, 2B, & 3

- 10 % Black Eyed Susan (*Rudbeckia hirta*)
- 6.25% Cornflower (*Centaurea cyanus*)
- 6.25% Corn Poppy (*Papaver rhoeas*)
- 8 % Cosmos (*Cosmos bipinnatus*)
- 7.5 % Dames Rocket (*Hesperis matronalis*)
- 10 % Evening Primrose (*Oenothera hookeri*)
- 5 % Gaillardia (*Gaillardia pulchella*)
- 10 % Gayfeather (*Liatris spicata*)
- 1 % Gold Yarrow (*Achillea filipendulina*)
- 10 % Lance Leaved Coreopsis (*Coreopsis lanceolata*)
- 5 % Ox Eyed Daisy (*Chrysanthemum leucanthemum*)
- 5 % Plains Coreopsis (*Coreopsis tinctoria*)
- 10 % Purple Coneflower (*Echinacea purpurea*)
- 5 % Rocket Larkspur (*Delphinium ajacis*)
- 1 % White Yarrow (*Achillea millefolium*)

The wildflower seed mix shall conform to the following:

75 % Minimum Germination

98 % Minimum Purity

(g) Cover Companion Seed for use with Wildflower Seed Mix

100 % Hard Fescue (*Festuca longifolia*) or Sheep Fescue (*Festuca ovina*)

920.04.03 Sod. Sod shall either be Maryland Certified or Maryland Approved Sod and shall comply with the Maryland Turfgrass Law and Certification Regulations of the Annotated Code of Maryland. Each load of sod shall bear a Maryland State Approved or Certified label at the time of delivery on the job.

The sod shall be well rooted and shall be grown in the state of Maryland. It shall be field grown for a minimum of 12 months. Once cut and rolled, sod shall be placed within 48 hours. It shall be cut in strips not less than 14 in. (350 mm) nor more than 20 in. (500 mm) wide. Sod shall be machine cut to a uniform thickness of 3/4 in. (19 mm), plus or minus 1/4 in. (6 mm), at the time of cutting. Thickness shall exclude top growth and thatch. Sod shall be relatively free of thatch, 3/8 in. (10 mm) or less at time of cutting. Prior to cutting, sod shall be mowed to a height of 1½ to 2½ in. (40 to 65 mm) for Bluegrass, 3/4 to 1 in. (19 to 25 mm) for Bermudagrass, and 2 to 2½ in. (50 to 65 mm) for Tall Fescue.

920.05 MULCH.

920.05.01 Shredded Hardwood Bark. Shredded hardwood bark shall consist of the bark from hardwood trees which has been milled and screened to a maximum 4 in. (100 mm) particle size and provide a uniform texture free from sawdust, toxic substances, and foreign materials.

920.05.02 Wood Chips. Wood chips shall be produced by a chipping machine to a size acceptable to the Engineer. Chips shall not have been subjected to any conditions that would shorten their life or cause them to lose any of their value as a mulch. Wood chips shall be free from bark,

leaves, twigs, wood shavings, sawdust, toxic substances, and any foreign material.

920.05.03 Straw and Hay. Straw shall consist of thoroughly threshed cereal grains. Hay shall consist of forage grasses and legumes. Straw and hay shall be free of noxious weeds and weed seeds as specified in 920.04. Straw and hay shall be visually inspected to insure that it is free from mold, foreign substances, plant parts of Canada Thistle, Johnsongrass, or Phragmites, and is in an air-dry condition suitable for placing with mulch blower equipment.

920.05.04 Wood Cellulose Fiber. Wood cellulose fiber shall be a processed wood product having uniform fiber characteristics which will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form a homogeneous slurry. The fiber shall perform satisfactorily in hydraulic seeding equipment without clogging or damaging the system. The slurry shall contain a green dye that will provide easy visual inspection for uniformity of application.

The manufacturer shall furnish certification as specified in TC-1.02 showing that the material conforms to the following:

WOOD CELLULOSE FIBER REQUIREMENTS	
Particle Length, in. (mm)	Approximately 1/2 (13)
Particle Thickness, in. (mm)	Approximately 1/16 (1.5)
Net dry Weight Content	Minimum as stated on bag
TAPPI* T 509, pH	4.0 - 8.5
Ash Content, TAPPI* Standard T 413, % max	7.0
Water Holding Capacity, % min	90

The material shall be delivered in packages of uniform weight which shall not exceed 75 lb (34 kg) net weight and shall bear the name of the manufacturer, the net weight, and a supplemental statement of the net weight content.

920.06 SOIL STABILIZATION MATTING. Soil stabilization matting shall consist of a machine produced mat of wood fibers, wood excelsior, or biodegradable man-made fibers. Matting shall be smolder resistant. A chemical, if used, shall be nonleaching, nontoxic to vegetation and the germination of seed, and noninjurious to the skin.

Matting shall have a uniform thickness and distribution of fibers throughout. The top and bottom of the excelsior matting shall be covered with a biodegradable extruded plastic netting having a maximum mesh opening of 2 x 2 in. (50 x 50 mm) or covered on the top side with netting machine sewn on 2 in. (50 mm) centers along the longitudinal axis of the material. The average breaking strength of any two strands of netting shall be 5 lb (22 N) minimum. The netting shall be entwined with the matting fibers in a manner which shall provide sufficient reinforcement against damage during handling and placement and shall resist degradation for a minimum of six months and a maximum of one year. The width of rolls of matting shall be not less than 40 in. (1016 mm) nor greater than 96 in. (2438 mm). Soil stabilization matting shall be from the Administration's approved Prequalified Materials List for the use specified.

920.06.01 Staples. Staples shall be "U" or "T" shaped steel wire having minimum gauges of No. 11 (3.061 mm) and No. 8, (4.115 mm) respectively. The "U" shaped staples shall average 1 to 1½ in. (25 to 40 mm) wide and be a minimum of 6 in. (150 mm) long. The "T" shaped staples shall have an 8 in. (200 mm) leg, a 1 in. (25 mm) secondary leg and a 4 in. (100 mm) head.

920.07 PLANT MATERIALS.

920.07.01 Plants. All plants, unless otherwise specifically permitted, shall conform to the standards of the current edition of "American Standard for Nursery Stock" as approved by the American Standards Institute, Inc.

All plants, unless otherwise specifically permitted, shall be nursery grown and shall have been grown within plant hardiness zones 5, 6, 7 or the Virginia portion of zone 8A as recorded in the current edition of "Plant Hardiness Zone Map," prepared by the U.S. National Arboretum, Agricultural Research Service, U.S. Department of Agriculture.

All plant materials shall have normal, well developed branches and a vigorous root system. They shall be healthy plants free from physical defects, plant diseases, and insect pests. Plant materials grown in fields or blocks which show evidence of containing any parts of Johnsongrass or Canada Thistle will not be accepted.

Shade and flowering trees shall be symmetrically balanced. Major branches shall not have V shaped crotches capable of causing structural weakness. Trunks shall be free of unhealed branch removal wounds greater than a 1 in. (25 mm) diameter.

Shade trees shall have a single main trunk. Trunks shall be free of branches below the following heights:

1½ to 2½ in. (40 to 65 mm) caliper trees - 5 ft (1.5 m) height

3 in. (75 mm) caliper and greater trees - 6 ft (1.8 m) height

920.07.02 Plant Names. The authority for all plant names shall be the current printing of "Hortus Third." Representative samples of every shipment of plant materials shall be labeled as to genus, species and specified size.

920.07.03 Plant Inspection. The initial inspection for conformance with these Specifications will be made at the nursery, holding area or job site. The condition of all plant material will be subject to reinspection for the life of the Contract. Inspection and tagging of plant material with an Administration seal prior to digging will be at the option of the Engineer. Material arriving with broken seals (if tagging is required), broken or loose root balls, mechanical damage, insufficient protection and shriveled or undeveloped roots will not be accepted. All container grown plants shall be well rooted, vigorous and established in the size pot specified, shall have well balanced tops for their pot size and shall not be root bound.

All plant materials shall be declared and certified free from disease and insects of any kind as required by law for the necessary interstate or interdistrict transportation.

920.07.04 Plant Digging and Handling. All plants shall be dug in conformance with the digging Specifications in the current edition of “American Standard for Nursery Stock,” unless otherwise specified.

All bare root deciduous plants shall be shipped in a dormant condition. Roots shall be adequately protected and kept moist.

920.07.05 Substitute Plants. No substitutions shall be made without the permission of the Engineer.

In cases where plant materials are not available at the time of planting, the Contractor shall submit, in writing, evidence that the plants are unavailable. The Engineer will determine a suitable substitution.

920.08 MISCELLANEOUS LANDSCAPING ITEMS.

920.08.01 Water. Water used in the planting, establishing, or caring for vegetation shall be free from any substance that is injurious to plant life.

920.08.02 Peat Moss. Peat moss shall be milled sphagnum peat moss and shall be free from woody substances.

920.08.03 Peat Humus. Peat humus shall originate from fresh water sites of sedge and reed peat deposits in which the organic matter consists of incompletely decomposed plant residues containing a minimum of 70 percent organic material by weight and a negligible amount of woody matter by visual inspection. Inorganic material shall consist only of sand, silt and clay without inclusion of gravel, debris or toxic compounds. Peat humus with a pH value of less than 4.5 shall be corrected to a value of 6.5 by the addition of limestone as directed by the Engineer. Samples of peat humus will be taken by the Engineer and will be tested for conformance to Federal Specification Q-P-166.

920.08.04 Manure. Manure shall be dehydrated cow manure as approved by the Engineer.

920.08.05 Screened Compost Sewage Sludge. Screened compost sew-

age sludge will be approved for distribution by the Maryland Department of the Environment and subject to approval by the Engineer.

920.08.06 Insecticide. Insecticide shall be an EPA approved chemical that provides protection against insect pests. The insecticide will be subject to approval by the Engineer.

920.08.07 Herbicide. Herbicide shall be an EPA approved chemical to control and prevent regrowth of undesirable vegetation. The herbicide will be subject to approval by the Engineer.

920.08.08 Marking Dye. Marking dye shall be herbicide compatible and oil or water soluble, as required. Marking dye shall be from a commercial source as approved by the Engineer.

920.08.09 Stakes. Stakes for supporting trees shall be rough sawn, straight grain hardwood reasonably free from knot holes, bark, wane, warp and splits, as determined by the Engineer. Stakes shall be full cut 2 x 2 in. (50 x 50 mm) thickness. The length shall be as specified in the Contract Documents.

920.08.10 Outline Stakes. Outline stakes shall be full cut 1 3/4 x 1 3/4 in. (45 x 45 mm) sound hardwood, 48 in. (1.2 m) long, as approved by the Engineer. They shall have the words "MOW LIMIT" stenciled in orange paint vertically on one side in 1 1/2 in. (40 mm) letters beginning within 2 in. (50 mm) from the top of the stake.

920.08.11 Wire. Wire shall be No. 12 gauge (2.680 mm) and 14 gauge (2.032 mm) new annealed galvanized wire, as approved by the Engineer.

920.08.12 Wire Rope. Wire rope shall be 1/4 in. (6 mm) zinc coated steel wire seven strand as commonly used for guying large trees and as approved by the Engineer.

920.08.13 Cable Clamps. Cable clamps shall be galvanized or cadmium plated as approved by the Engineer.

920.08.14 Hose. Hose shall be 5/8 in. (16 mm) inside diameter corded synthetic rubber hose or as approved by the Engineer.

920.08.15 Turnbuckles. Turnbuckles shall be galvanized or cadmium plated with 4½ in. (115 mm) openings and 5/16 in. (8 mm) threaded ends with screw eyes.

920.08.16 Anchors. Tree anchors shall be earth anchors of a type commonly used for anchoring large trees and as approved by the Engineer.

920.08.17 Wrapping Material. Wrapping material for trees shall be clean new burlap 6 to 7 oz/yd² (200 to 240 g/m²) in strips 4 to 6 in. (100 to 150 mm) wide.

920.08.18 Twine. Twine used for tying wrapping on trees shall be three ply untreated jute twine as approved by the Engineer.

920.08.19 Antidesiccant. Antidesiccant shall be an approved emulsion which will provide a film over plant surfaces permeable enough to permit transpiration.

920.08.20 Tree Wound Dressing. Tree wound dressing shall be an asphalt based emulsion prepared especially for tree pruning operations.

920.08.21 Pegs. Pegs shall be wooden wedges ½ x 1 x 6 in. (13 x 25 x 150 mm) to ½ x 1 x 12 in. (13 x 25 x 300 mm) as approved by the Engineer.

920.08.22 Water Absorbent Gel. Water absorbent gel shall be a cross linked polyacrylamide horticultural product used to maintain moisture around bare root plants and as a soil conditioner. Formulas used shall conform to the manufacturer's recommendations.

SECTION 921 - MISCELLANEOUS

921.01 WATER FOR CONCRETE MIXES. Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed the following limits:

Bridge Superstructure and Prestressed Concrete	500 ppm
Latex Modified Concrete	50 ppm
Other Concrete and Water Used in Curing	1000 ppm

921.02 CALCIUM CHLORIDE. Solid calcium chloride shall conform to M 144, Type S, Grade I, Class A. Calcium chloride in solution shall contain a minimum of 30 percent solids. The solution shall also contain an approved wetting agent in a quantity designated by the Engineer. When analyzed on a dry basis in conformance with MSMT 601, the residue shall conform to M 144, Grade 2 or Grade 3.

921.03 LIME.

921.03.01 Hydrated lime shall conform to the chemical requirements of C 206, Type N when used in finishing or C 207, Type N when used for masonry.

921.03.02 Hydrated lime for soil stabilization shall have a minimum combined calcium oxide and magnesium oxide content of 65 percent when tested in conformance with C 25 and shall conform to the following gradation:

SIEVES U.S. STANDARD	PERCENT RETAINED, max
3/8 in. (9.5 mm)	0
No. 30 (0.600 mm)	3
No. 200 (0.075 mm)	25

921.03.03 Quicklime shall have a combined calcium oxide and magnesium oxide content of 75 percent minimum and a gradation of 100 percent passing the 3/8 in. (9.5 mm) sieve when tested in conformance with C 25.

921.04 EPOXY ADHESIVES. Epoxy resin bonding material shall consist of a thermosetting epoxy resin and a hardener. The individual components of mixed epoxy shall not settle or skin and contain no volatile solvents, lumps or foreign materials. The epoxy shall conform to C 881. Unless otherwise specified, epoxy adhesive used for bearing and expansion pads shall be nonsagging.

The manufacturer shall furnish certification as specified in TC-1.02. The certification or data sheet shall show actual test results for each required property of the type, grade and class of epoxy submitted, and shall accompany each sample. The manufacturer shall supply actual bond test results for each batch submitted for use.

921.05 STRUCTURAL TIMBER AND LUMBER. The manufacturer shall furnish certification as specified in TC-1.02. Structural timber and lumber shall conform to M 168.

921.06 TIMBER PRESERVATIVES. Preservatives and pressure treatment for timber shall conform to M 133.

921.07 CONDUITS. Conduit shall conform to the following:

921.07.01 Metallic Conduit.

MATERIAL	SPECIFICATION
Electrical Metallic Tubing	UL 797
Intermediate Metal Conduit	UL 1242
Rigid Metal Conduit	UL 6
Rigid Steel Conduit, Zinc Coated	ANSI C80.1
Metallic Outlet Boxes	UL 514A
Fittings for Conduit and Outlet Boxes	UL 514B

921.07.02 Nonmetallic Conduit. The manufacturer shall furnish certification as specified in TC-1.02. Each length shall be stamped or embossed with the grade or type and applicable UL or NEMA designation.

MATERIAL	SPECIFICATION
Schedule 40 and 80 Rigid Polyvinyl Chloride (PVC) Conduit	UL 651
Electrical Plastic Tubing (EPT) and Electrical Plastic Conduit (EPC-40 and EPC-80)	NEMA TC 2
Nonmetallic Outlet Boxes, Flush Device Boxes and Covers	UL 514C
Electrical Nonmetallic Conduit (ENC)	NEMA TC 13
PVC Fittings for use with Rigid PVC Conduit and Tubing	NEMA TC 3
Flexible PVC Coated Conduit	UL 360
Liquid Tight Flexible Nonmetallic Conduit for Detector Sleeves	UL 1660

921.07.03 PVC Coated Metallic Conduit.

MATERIAL	SPECIFICATION
PVC Externally Coated, Galvanized, Rigid Steel Conduit and Electrical Metallic Tubing	NEMA RN 1

921.08 STRAW BALES. Straw bales for erosion and sediment control shall conform to the Contract Documents and shall be approximately 14 x 18 x 36 in. (360 x 460 x 910 mm).

921.09 GEOTEXTILES. Geotextiles shall conform to the class specified in the Contract Documents. The geotextile shall be manufactured from fibers consisting of long chain synthetic polymers, composed of a minimum 85 percent by weight of polyolephins, polyesters or polyamides. The geotextile shall resist deterioration from ultraviolet exposure. Geotextiles

used in the construction of silt fence shall contain sufficient amounts of ultra-violet ray inhibitors and stabilizers to provide a minimum of 12 months of expected usable construction life at a temperature range of 0 to 120 F (-18 to 49 C).

All values specified are minimum or maximum roll values.

Classes A through E Geotextiles shall have a 0.010 cm/sec minimum permeability when tested in conformance with D 4491, and an apparent minimum elongation of 20 percent when tested for conformance with the grab tensile strength requirements specified below. Classes A through E Geotextiles shall also conform to the following additional requirements:

GEOTEXTILE CLASS	MAXIMUM APPARENT OPENING SIZE mm	GRAB TENSILE STRENGTH lb (N) min	MINIMUM BURST STRENGTH psi (MPa)
A	0.30	250 (1110)	500 (3.4)
B	0.60	200 (890)	320 (2.2)
C	0.30	200 (890)	320 (2.2)
D	0.60	90 (400)	145 (1.0)
E	0.30	90 (400)	145 (1.0)

Class F Geotextiles (Silt Fence) shall have a 50 lb/in. (8.8 kN/m) minimum tensile strength and a 20 lb/in. (3.5 kN/m) minimum tensile modulus when tested in conformance with D 4595. The material shall also have a 0.3 gal/ft² (12.2 l/m²) per minute minimum flow rate and a 75 percent minimum filtering efficiency when tested in conformance with D 5141.

The properties shall be determined as follows:

TEST	METHOD
Apparent Opening Size	D 4751
Grab Tensile Strength	D 4632, Grab Test - 4 x 8 in. (100 x 200 mm) specimen, 1 x 2 in. (25 x 50 mm) clamps; 12 in. (300 mm)/minute strain rate both principal directions of geotextile.
Burst Strength	D 3786

Sewing of the geotextile will be allowed provided it conforms to the following:

- (a) Seams shall be either “J” or “butterfly” type and shall utilize a lock stitch.
- (b) Seams shall conform to the tensile strength requirements for the geotextile when tested across the seam.
- (c) The thread for seaming shall be of equal or greater durability than the geotextile itself.

921.10 POLYETHYLENE (PE) MANHOLES. PE manholes shall conform to D 1248, Type III, Class C, Category 3, Grade P34. Working drawings shall be submitted to the Engineer prior to fabrication.

Compressive strength shall be determined in conformance with D 2412, modified pipe stiffness test. Pipe stiffness shall be a minimum of 12 psi (80 kPa) at 5 percent deflection, including joints. Axial compressive strength shall be a minimum of 10 000 lb (68.9 MPa) at less than 3 percent deflection.

PE manholes for storm drains shall be manufactured with an invert bowl which will not interrupt flow. Manholes for sanitary sewers shall have a factory molded invert for channeled flow.

The manufacturer shall furnish certification as specified in TC-1.02. The certification shall accompany each shipment of PE manholes and shall show

actual test results, the quantity of manhole sections and date of manufacture. Manholes shall be marked with the manufacturer's name and trademark.

921.11 RAPID HARDENING CEMENTITIOUS MATERIALS FOR CONCRETE PAVEMENT REPAIRS. Materials shall be a dry, packaged cementitious mortar having less than 5 percent by weight of aggregate retained on the 3/8 in. (9.5 mm) sieve and shall conform to the following requirements:

Classification.

Class I - For use at ambient temperatures below 50 F (10 C).

Class II - For use at ambient temperatures of 50-90 F (10-32 C).

Class III - For use at ambient temperatures above 90 F (32 C).

Chemical Requirements. The material shall conform to the chemical requirements of C 928 and contain no organic compounds such as epoxy resins or polyesters as the principal binder.

Physical Requirements. The material shall conform to the following when tested in conformance with MSMT 725:

TEST	METHOD
Apparent Opening Size	D 4751
Grab Tensile Strength	D 4632, Grab Test - 4 x 8 in. (100 x 200 mm) specimen, 1 x 2 in. (25 x 50 mm) clamps; 12 in. (300 mm)/minute strain rate both principal directions of geotextile.
Burst Strength	D 3786

Bond Strength, 7 days, psi (MPa) min	2000 (13.8)
Length Change, increase after 28 days in water, based on length at 3 hr, % max	+ 0.15
Length Change, decrease after 28 days, % max	-0.15
Freeze Thaw, loss after 25 cycles in 10% CaCl ₂ solution, % max	8
Initial setting time, minutes min	10

Marking. All packages delivered to the project shall be marked with the following information:

- (a) Date material was packaged.
- (b) Approximate setting time.
- (c) Recommended dosage of water or liquid component.
- (d) Mixing instructions.
- (e) Class or temperature range.

Certification. The manufacturer shall furnish certification as specified in TC-1.02 showing the actual test results for each class and type of material submitted to the Laboratory.

921.12 DAMPPROOFING AND WATERPROOFING MEMBRANE. The adhesive side of the membrane shall be protected with a special release paper that can be easily removed for installation. The membrane shall conform to the following requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATIO N LIMITS
Grab Tensile Strength, lb/in. kN/m) at 12 in. (300 mm)/minute rate of loading, min	D 1682	70 (12.2)
Pliability, 180 deg. bend, 1 in. (25 mm) mandrel @ 20 F (-7 C)	D 146	unaffected
Resistance to Puncture, lb (kg) min	E 154 (square mounting frame method)	40 (18)
Permeance, perm (kg/Pa x s x m ²), max	E 96, Method B	0.1 (5.74 x 10 ⁻¹²)
Weight, oz/yd ² (kg/m ²) min	D 3776	40 (1.36)
Primer	-	as specified by the manufacturer

Roll and sheet waterproofing membrane may be accepted on certification. The manufacturer shall furnish certification as specified in TC-1.02 with actual test results showing that the material conforms to these Specifications.

SECTION 922 - PREFABRICATED EDGE DRAINS

922.01 Certification. The manufacturer shall furnish certification as specified in TC-1.02.

922.02 Prefabricated Edge Drains. Prefabricated edge drains shall be flexible, rectangular conduit consisting of supporting drainage core encased in a geotextile.

Drainage Core. Drainage core material shall be manufactured from polymers having a high resistance to deterioration by pavement deicing salts, petroleum based materials and naturally occurring soil chemicals. The core shall have sufficient flexibility to withstand bending and handling without damage or significant weakening.

The core geotextile contact point spacing for post and cusped sheet type cores shall not exceed 1.125 in. (31 mm). Elongated pipe core sections shall have a 7.5 in./ft (625 mm/m) minimum open area to allow lateral flow into the core. Cores with support on only one side shall have a minimum of 5 percent of the area of that support side in unobstructed flow. The drain core shall conform to the following requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Thickness, in. (mm) min	-	0.75 (19)
Compressive Strength, psi (kPa) (20% max deformation), min	NOTE 1	40 (275)
In-plane Flow Rate, gal/min/ft (l/min/m) of width, min	D 4716 NOTE 2	15 (185)
NOTE 1: D 1621 for crushed sheet and post type cores. D 2412 for elongated pipe type cores.		
NOTE 2: 10 psi (70 kPa) load after 100 hr at a hydraulic gradient of 0.1.		

Geotextile Wrap. The geotextile wrap for prefabricated edge drain shall be manufactured from fibers consisting of long chain synthetic polymers composed of a minimum 85 percent by weight of polyolefins, polyesters or polyamides. The geotextile shall resist deterioration from ultraviolet exposure and shall be suitable for subsurface applications.

The fabric shall be bonded to contact points of supporting core for post and cuspated sheet type cores to assure that the geotextile does not sag into the core flow area. The geotextile shall be tightly stretched over the core for elongated pipe type cores.

Geotextile shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Apparent Opening Size, mm max	D 4751	0.30
Grab Tensile Strength, lb (N) min	D 4595	90 (400)
Apparent Elongation, % min	D 1682 NOTE 1	50
Burst Strength, psi (kPa) min	D 3786	145 (960)
Water Permeability, cm/sec min	D 4491	0.01
Peel Strength, lb/ft (N/m) of width	D 1876	35 (510)
(Geotextile to core for cuspated and post type core)		
Seam Strength, lb/ft (N/m) of width	D 4595	35 (510)
NOTE 1: Use 4 x 8 in. (100 x 200 mm) specimen, 1 x 2 in./min (25 x 50 mm/min) strain rate for both principal directions of the geotextile.		

922.03 Fittings. Fittings for the pavement edge drain systems, including, but not limited to end seals, splices, outlets and shunts shall conform to the manufacturer’s recommendations and shall be of sufficient strength to withstand construction handling and permanent loading. All fittings shall be approved by the Engineer.

922.04 Outlet Pipe. Pipe for outlets shall be 6 in. (150 mm) minimum diameter and shall conform to 905.01.

SECTION 923 - SLURRY SEAL

923.01 Aggregates. Aggregates shall be crushed stone, compatible with the emulsion and shall conform to Section 901.

923.02 Mineral Filler. Refer to Section 901.

923.03 Emulsified Asphalt. Emulsified asphalt shall conform to M 208, Grade CSS-1h, except that the cement mixing test is waived. Emulsified asphalt shall not separate before placement of SS or LMSS.

923.04 Latex Modified Emulsion. The latex modifier and other emulsifiers shall be milled into the asphalt cement. The emulsified asphalt shall be modified by the addition of 3.0 ± 0.4 percent latex solids by weight of the asphalt. The latex modifier shall be an unvulcanized styrenebutadiene rubber (SBR) or 100 percent natural latex in liquid form. The manufacturer shall furnish certification as specified in TC-1.02 showing actual test results conforming to these Specifications.

923.05 Mix Design Approval. Mix design data shall be submitted to the Engineer for approval, at least three weeks in advance of the paving operation. The mix design shall list the ingredients and their proportions, as well as the gradation of the proposed aggregate.

The SBR latex modifier shall conform to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Styrene-butadiene Ratio	24:76 \pm 1.5
Solids Content, % min	60
pH, max	6.2
Weight Per Gallon, (m ³), Wet Basis @ 25 C, lb (kg) min Dry Basis @ 25 C, lb (kg) min	7.9 (950) 4.5 (540)

Latex modified emulsion CSS-1h shall conform to M 208 modified as follows:

The 100 percent natural latex shall be a high ammonia natural latex conforming to D 1076, Type I.

The mix design report shall show test results conforming to the following:

TEST PROPERTY	SPECIFICATION LIMITS
MSMT 403, Mixing Test, minutes min	2
MSMT 403, Setting Time, minutes max	30
MSMT 403, Water Resistance	Slight Discoloration
MSMT 403, Wet Track Abrasion, g/ft ² (g/m ²) max	75 (810)
International Slurry Seal Association (ISSA) TB 139, Set Time Test, 30 minutes, kg/cm min	12

The percent of residual asphalt, based on the dry aggregate weight, shall be between 8.0 and 12.5 for Type II Mix and 7.0 and 11.0 for Type III Mix, each having a control tolerance of ± 1.0 percent.

The Contractor shall submit sufficient material to the Engineer for testing the mix design should corroborating information be desired.

RESIDUE REQUIREMENTS	
TEST PROPERTY	SPECIFICATION LIMITS
Penetration @ 25 C, min	30
Ductility @ 25 C, min @ 4 C, min	150 100
Softening Point, (R and B), F (C) min	140 (60)
Cement Mixing Test	Waived

The latex modified emulsion, after standing undisturbed for 24 hours, shall be a uniform color throughout.

923.06 Mix Design. The mix design shall conform to the following:

The stability shall be a minimum of 1800 lb (8.0 kN) and the flow shall be 0.06 to 0.16 in. (1.5 to 4.1 mm) when tested in conformance with T 245, Modified (modification permits air drying of the mixture at 70-75 F {21-24 C} for a minimum of 24 hours, followed by placement in a 140 F {60 C} oven and drying to a constant weight prior to reheating and placing in molds).

SECTION 924 THRU 949 - RESERVED

SECTION 950 - TRAFFIC MATERIALS

950.01 PRECAST CONCRETE TRAFFIC BARRIER. Precast concrete traffic barrier shall conform to the Contract Documents. Welded wire fabric shall conform to 908.05.

950.02 RESERVED.

950.03 REFLECTORIZATION OF SIGNS AND CHANNELIZING DEVICES.

950.03.01 Type III Retroreflective Sheeting. Unless otherwise specified signs and channelizing devices such as tubular markers, drums and cones shall be reflectorized with reflective sheeting conforming to the Federal Highway Administration's (FHWA) Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, D 4956 and the following where identified in the Contract Documents:

MINIMUM REFLECTIVE INTENSITY VALUES FOR TYPE III SHEETING Minimum Coefficient of Retroreflection (R_A) cd/ft^2 ($cd \times lx^{-1} m^{-2}$)								
Observation Angle deg.	Entrance Angle deg.	Silver-White	Yellow	Red	Orange	Green	Blue	Brown
0.2	+50	75	40	8.4	25	10.3	2.9	1.6
0.5	+50	35	20	6.8	10	6.4	2.0	1.1

The Contractor shall furnish certification as specified in TC-1.02 that the reflective sheeting conforms to these requirements for each batch.

950.03.02 High Performance Wide Angle Retroreflective Sheeting. When specified in the Contract Documents, high performance wide angle retroreflective sheeting shall conform to FHWA Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, D 4956 and the following:

MINIMUM REFLECTIVE INTENSITY VALUES FOR HIGH PERFORMANCE WIDTH ANGLE PRISMATIC LENS SHEETING Minimum Coefficient of Retroreflection (R_A) cd/ft^2 ($cd \times lx^{-1} m^{-2}$)								
Observation Angle	Entrance Angle	White	Yellow	Red	Orange	Green	Blue	Fluorescent Orange
0.2	- 4	800	660	215	450	75	43	200
0.2	+30	400	340	100	250	30	20	120
0.2	+50	35	23	6.6	16	1.8	1.0	50
0.5	- 4	200	160	45	120	18	9.8	80
0.5	+30	100	85	26	70	10	5.0	50
0.5	+50	30	20	6.4	16	2.5	2.0	20

950.03.03 Temporary roll up warning signs shall conform to D 4956, Type VI.

950.03.04 Black sheeting shall be nonreflective.

950.04 OVERHEAD SIGN STRUCTURES. Unless otherwise specified in the Contract Documents, structural steel shall conform to A 709, Grade 36; steel tubes or pipes shall conform to A 595, Grade A or API 5-LX52. Design and minimum thickness of material shall conform to AASHTO Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. All steel shall be galvanized as specified in A 123. Bolts and fasteners shall conform to A 153.

950.05 BACKFILL MATERIAL FOR TRENCHES FOR BURIED CABLE. Material to backfill buried cable trenches shall conform to the following:

The lower 1 ft (0.3 m) depth of trench shall be fine aggregate conforming to Section 901. Material above the 1 ft (0.3 m) depth shall be select material conforming to Section 916.

950.06 ELECTRICAL CABLE AND WIRE. Electrical cable and wire shall be the standard commercial product of the manufacturer and shall have been manufactured not more than one year prior to the date of the Contract. All cable and wire shall be made of copper.

950.06.01 Direct Burial Cable. Direct burial cable shall be single conductor, stranded, with an unshielded, chemically crosslinked thermosetting polyethylene insulation rated for 600 volts. The cable shall be suitable for direct earth burial or installation in ducts or conduit and shall conform to Underwriters' Laboratories Type USE, XHHW or THW and shall bear the applicable UL labels denoting type, size, stranding, manufacturer's name and surface marking or molded ridges for phase and neutral identification. Sizes shall be as specified in the Contract Documents.

950.06.02 Building Cable and Wire. Building cable and wire shall be 600 volt, plastic insulated, nylon jacketed and shall conform to Underwriters' Laboratories Type THWN/THHN and shall bear the applicable "UL" labels denoting type, size, stranding, manufacturer's name and surface marking or molded ridges for phase and neutral identification. Sizes shall be as specified in the Contract Documents.

950.06.03 Cable Duct. Cable duct shall consist of cables preinstalled in

either a polyvinyl chloride (PVC) or polyethylene (PE) plastic duct conforming to NEMA TC 7 and the National Electrical Code. PVC shall conform to D 3485. PE duct shall be manufactured from black, virgin, high density PE resin conforming to D 1248, Type III, Grade P34, Class C, Category 5. Minimum inside diameter of duct shall be 1 in. (0.3 m). Cable shall be rated for 600 volts.

950.06.04 Ground Wire and Rods. Ground wire shall be bare medium drawn copper. Ground wire installed underground shall be of the size (solid or stranded) configuration shown in the Contract Documents. Ground rods shall be 3/4 in. (19 mm) diameter, a minimum of 10 ft (3 m) in length, with a steel core and copper jacket.

950.06.05 Traffic Signal Cable. Traffic signal cable shall conform to IMSA Specification 19-1, and shall be stranded. Unless otherwise indicated, conductors shall be No. 14 AWG.

950.06.06 Loop Detector Lead-In Cable. Loop detector lead-in cable shall be two conductor, No. 14 AWG, PE jacketed, conforming to IMSA Specification 50-2.

950.06.07 Loop Detector Wire. Loop detector wire shall be single conductor, 600 volt, No. 14 AWG, 19 strand wire in a flexible PE tubing.

950.06.08 Voice Grade Communication Cable. Self-supporting cable shall be solid No. 19 AWG and conform to IMSA 40-4. Underground cable shall conform to IMSA 60-2.

950.07 LIGHTING STRUCTURES. Lighting structures shall conform to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, based on 90 mph (145 km/h) wind loads, luminaire weight of 70 lb (32 kg) and luminaire projected area of 3 ft² (0.3 m²).

Ground mounted lighting structures shall consist of a one piece, round tapered shaft, a cast steel anchor base for steel structures and a cast aluminum base for aluminum structures, bracket arms, complete with all neces-

sary accessories including anchor bolts, pole top, shims, grounding lug, and handhole.

Steel shafts shall conform to A 595, Grade A. After forming and welding, the shaft shall have a smooth finish with only one longitudinal and no transverse welds. Steel bracket arms and mounting brackets shall conform to A 53, Schedule 40. Structures shall be either mechanically or hot-dipped galvanized. The coating shall conform to the thickness, adherence, and quality requirements of A 123.

Aluminum shafts and bracket arms shall be spun from one piece of extruded tubing conforming to B 241, 6000 T6 series alloy. The shaft and bracket shall be cold worked to form the required taper.

Each lighting structure shall be provided with a permanent tag which shall be 2 x 4 in. (50 x 100 mm) fabricated from clear anodized 1/16 in. (1.5 mm) thick aluminum. The edge shall be smooth and corners rounded and the tag shall fit the lighting structure shaft. Tags shall be secured to shafts by means of four 1/8 in. (3 mm) diameter 18-8 stainless steel round head drive screws or self-tapping screws. The identifying letters or numerals shall be not less than 3/4 in. (19 mm) high with stroke of not less than 3/16 in. (5 mm). Identifying letters or numerals shall be as specified in the Contract Documents or as directed by the Engineer.

950.08 SIGNS. The manufacturer or supplier shall furnish certification as specified in TC-1.02.

950.08.01 Sheet Aluminum Sign Panels. Sign panels shall conform to B 209, with an anodized mill finish. Alloys shall be either 6061 T6 or 5052-H38. Recycled alloys will not be accepted.

950.08.02 Extruded Aluminum Sign Panels and Edge Strip. Extruded aluminum sign panels and edge strip shall conform to B 221, alloy 6063 T6.

950.08.03 Hardware. Hardware shall be clear anodized, conforming to one of the following: B 209, alloy 2024 T4; B 211, alloy 2024 T4, 6262 T9, 6061 T6, 7075 T6 or 2017 T4.

950.09 STEEL SPAN WIRE. Unless otherwise specified in the Contract Documents, steel span wire shall be 1/4 or 3/8 in. (6 or 10 mm) diameter, seven wire strand, galvanized as specified in A 475, Class C.

950.10 CONDUIT. Conduit shall conform to Sections 805 and 921.

950.11 ELECTRICAL CONDUIT DETECTOR TAPE. Electrical Conduit detector tape shall consist of one layer of aluminum foil laminated between two layers of inner plastic film. The foil shall be 3 in. (75 mm) wide with a tensile strength of 60 lb (260 N). The plastic film shall have a minimum thickness of 4½ mil (0.11 mm).

950.12 LUMINAIRES AND LAMPS. Unless otherwise specified the luminaire shall be a complete lighting device consisting of a housing, support clamp, reflector, refractor or flat lens, socket, lamp, integral ballast, terminal block, associated hardware, and necessary wiring. All parts of the luminaire shall incorporate the latest ratings and design improvements up to the date of bid opening. Luminaires shall incorporate individual photoelectric cells if specified. Exposed hardware shall be stainless steel.

950.12.01 Luminaire Construction.

- (a) The bracket arm mounted luminaire housing shall be cast aluminum with natural finish. The housing shall contain and support the reflector, refractor or flat lens, socket, ballast, terminal block and support clamp. Provisions shall be made for leveling and adjusting the luminaire to the specified transverse and longitudinal position to the roadway.

The refractor or flat lens retaining ring shall be securely latched with an operable hinge made from noncorrodible material and shall have a removable enclosure for the optical system.

The reflector shall be of specular polished Alzak aluminum or equivalent aluminum reflective surface. It shall be held firmly in the housing but shall be easily removed without the use of special tools. Sili-

cone rubber, ethylene propylene terpolymer, dacron felt gaskets or other gasketing materials as approved by the Engineer shall seal the optical assembly at the socket entry and between the refractor and reflector to make a dust tight optical system. The reflector shall be clean and free from scratches.

Glass for the refractor or flat lens shall be heat resistant, borosilicate glass and shall be free of imperfections. The optical system of the luminaire shall clearly indicate the street side and curb side.

The socket shall be mogul screw shell with large center contact spring providing a firm contact with the lamp base. The socket shall have lamp grips to prevent the lamp from loosening. The shell may be of the skeleton type or shrouded in porcelain. The contacts shall be identifiable. Socket extension adapters may be permitted for special applications as directed by the Engineer. Luminaires providing various ANSI-IES type of distribution by socket adjustment shall also include a means of identification to associate each lamp position with each distribution type. The socket adjustment shall provide positive positionings by means of index holes, lugs or notches. Slots with infinite settings will not be acceptable.

The ballast shall be a high power factor, auto regulator type, capable of operating from a multiple circuit and shall operate a high intensity discharge lamp of the type, wattage and voltage specified. Multi tap ballasts shall be provided where supply voltage is 277 volts or less. The ballast shall start the lamp at temperatures as low as -20 F (-35 C), and shall deliver rated lamp current at circuit voltage variation of plus or minus 10 percent. The primary power factor shall be not less than 90 percent with normal secondary load. The ballast assembly shall be provided with plug in connectors and installed on a hinged door to permit ready interchange of ballast.

Glare shields shall be provided on luminaires where specified in the Contract Documents or as directed by the Engineer. The glare shield shall cut off the upward component of light but shall not reduce the total output of the luminaire more than 3 percent.

- (b) Bridge underpass luminaires shall be a complete lighting device, consisting of a cast aluminum housing, a door with cast aluminum frame, and thermal shock resistant glass refractor attached to the frame with a stainless steel latch, hinges and retaining chain, a specular polished Alzak aluminum reflector, a shrouded adjustable porcelain socket and an integral ballast as specified above.

The refractor and reflector shall direct all useful light well below all normal driver viewing angles to assure that glare will be at a minimum.

- (c) Sign lighting luminaires shall be mercury vapor. A mercury vapor luminaire shall consist of a luminaire housing and a refractor/door assembly constructed of die cast aluminum. The refractor shall be a single piece molded thermal shock resistant borosilicate glass convex lens with discrete prism patterns. The refractor shall be permanently sealed to the door assembly with silicone adhesive around its perimeter. The reflector shall be a single piece dieform of sheet aluminum alloy 3002 or as approved by the Engineer, processed to Alcoa Class SI Alzak finish. A heavy duty mogul lampholder shall be securely mounted to the reflector with a galvanized steel bracket. The refractor/door assembly shall be nonpermanently sealed to the luminaire housing and reflector assembly with a single piece neoprene gasket to effectively seal the luminaire and locked in place by stainless steel springloaded latches. The refractor/door assembly shall open and be held captive by double pivot internally mounted stainless steel hinges, and it shall be openable and removable.

Weepholes shall be provided in the bottom of the housing in the lowest area of the luminaire as normally mounted.

The sign lighting luminaire shall be designed to properly illuminate the sign with the lamp source type and size as specified in the Contract Documents. The Contractor shall submit for the approval of the Engineer, working drawings showing locations and aiming angles of luminaires with relation to each of the signs of the various sizes.

950.12.02 Lamps shall be provided for luminaires of the type and wattage specified in the Contract Documents. Lamps shall be first line, high quality and will be as approved by the Engineer. Lamp wattage, horizontal or vertical initial lumens, rated lamp life, and percent of initial lamp lumens at end of rated lamp life shall be as follows:

TYPE	WATTS	INITIAL LUMENS	RATED LIFE (10 hr/start)	PERCENT INITIAL LUMENS
Deluxe Mercury	175	8 600	24 000	0.74
Deluxe Mercury	250	12 100	24 000	0.74
Deluxe Mercury	400	22 500	24 000	0.60
H.P. Sodium	100	9 500	20 000	0.74
H.P. Sodium	150	16 000	24 000	0.74
H.P. Sodium	200	22 000	24 000	0.72
H.P. Sodium	250	30 000	24 000	0.73
H.P. Sodium	310	37 000	24 000	0.72
H.P. Sodium	400	50 000	24 000	0.73
Metal Halide	250	20 000	10 000	0.8
Metal Halide	400	40 000	15 000	0.8

950.13 CONTROL AND DISTRIBUTION EQUIPMENT. Control and distribution equipment enclosures shall be dead front type weather-proof metal enclosed self supporting structures, as specified in the Contract Documents. Free standing enclosures shall be fabricated from sheet aluminum and shall be as specified herein. Panel and control equipment cabinets shall be the manufacturer’s standard enclosure for the type and application specified.

950.13.01 Circuit Breakers. Circuit breakers shall be molded case type having a minimum rating of 10 000 AIC and be quick make, quick break, thermal magnetic, trip indicating, and have common trip on all multiple breakers with internal tie mechanism. They shall have the current and voltage ratings, number of poles, and interrupting rating as specified in the Contract Documents and shall be treated to resist fungus and be ambiently compensated for the enclosure and proximity to adjacent breakers. All circuit breakers shall be the bolt in type.

950.13.02 Photoelectric Controls. Photoelectric controls shall be solid state, cadmium sulfide type with hermetically sealed silicone rectifier rated 120 volts, 60 cycle AC and 1000 watts maximum load. Built in surge protection shall be provided, and a fail safe operating feature shall be included so that the lighting circuits will remain energized in the event the photo control components become inoperative. Nominal operating levels of this control shall turn on at a minimum illumination value of 3 vertical FC (32 lx) and turn off at a maximum illumination value of 6 vertical FC (64 lx). These limitations shall be set by the manufacturer, and maximum tolerances of ± 20 percent for the specified value will be acceptable.

Photoelectric controls shall be twist lock type. A suitable mounting bracket with locking type receptacle and all other necessary mounting hardware shall be furnished.

950.13.03 Contactors and Relays. Contactors shall be held by permanent magnets, of the current ratings and number of poles specified in the Contract Documents. They shall be fully rated for all classes of load to 600 volts AC and shall have an interrupting rating of 600 percent of rated current. A HAND-OFF-AUTOMATIC selector switch shall be provided in the photoelectric cell circuit. Relays shall be the type, size and contact ratings as specified in the Contract Documents.

950.13.04 Panel Boards. Panel boards shall conform to Federal Specification W-P-115 and shall be suitable for operation on the voltage and type service specified in the Contract Documents. They shall be listed and labeled by the Underwriters' Laboratories, Inc. Panel boards shall be equipped with the number and size circuit breakers specified. Circuit breakers in panel boards shall conform to Federal Specification W-C-375 and shall be bolted to copper busses. Buss ratings shall be as specified.

950.13.05 Lightning Arresters. Lightning arresters shall be secondary type, having the specified number of poles and 0-650 volts RMS. Arresters shall be provided with suitable mounting brackets and all other necessary mounting hardware.

950.13.06 Control Power Transformers. Control power transformers shall be the dry type, two windings, of the size and voltage ratings specified in the Contract Documents.

950.13.07 Enclosures. Enclosures shall conform to the NEMA type specified. They shall have door clamps, solid neoprene gaskets, welded seams, stainless steel external hardware and continuous hinges with stainless steel pins. Enclosures shall have two weep-holes in the bottom and shall be equipped for padlocking. All enclosures shall be furnished with approved padlocks of the outdoor tumbler type. These locks shall be opened with the same key, and the Contractor shall furnish the Engineer with two keys for each lock.

950.13.08 Pad Mounted Enclosures. For ventilation, all cabinets shall be provided with louvered vents in the front door with a removable air filter.

- (a) Louvers shall satisfy the NEMA Rod Entry Test for 3R rated ventilated enclosure.
- (b) Filters for all cabinets shall be 16 in. (400 mm) in length x 12 in. (300 mm) in width x 1 in. (25 mm) in height (16"L x 12"W x 1"H).

The filter shall cover the vents and be held firmly in place with top and bottom brackets and a spring loaded upper clamp.

- (c) Exhaust air shall be vented out of the cabinet between the top of the cabinet and the main access door.

The exhaust area shall be screened with a screen type material having a maximum hole diameter of 1/8 in. (3 mm).

950.13.09 Thermostats and Fans. Thermostats shall be the line type, single pole, 120 volts, 10 amperes with a minimum range of 40 to 80 F (4 to 27 C).

- (a) A thermostatically controlled cooling fan shall be provided for all cabinets. The fan and thermostat shall be rated for 125 percent of capacity and they shall be mounted at the top of the cabinet.
- (b) The fan shall have a minimum rated capacity of 100 CFM air flow and a minimum rated design life of 100 000 hours.
- (c) The thermostat shall be manually adjustable, within a 10 degree range, from 70 F to 160 F (21 to 71 C).

950.14 Electrical Cable and Wire Connectors.

950.14.01 Cable Connectors and Connector Kits. Cable connectors and connector kits for use in lighting structures, handholes, junction or pullboxes and for terminating underground cables in lighting structures shall be rated for a minimum of 600 volt service. Cable connectors shall be compression type, applied by means of a compression tool. Connectors shall be fabricated from high strength copper alloy. Plated connectors fabricated from metals other than copper will not be accepted. Bolted type connectors shall be utilized for splicing bare ground conductors. Connectors shall be furnished in either of two styles as follows:

- (a) Style H shall be the parallel groove connector consisting of a metal body having two fully opened grooves or slots parallel to each other and separated by a portion of the center section of the body. The total circumference of each conductor shall be completely surrounded by metal when the connector is compressed.
- (b) Style S shall be the splicing sleeve type which shall consist of a crimpable plated copper sleeve with a thin metal wall or stop in the barrel centered between each sleeve end so the sleeve shall enclose equal lengths of the two conductors being spliced end to

end. The barrel of the sleeve shall be manufactured to fit specific ranges of conductor sizes. Installation shall conform to the manufacturer's recommendations.

950.14.02 Connector Kit Components. Each cable connector kit shall be furnished with all component parts described under the various listed types. Each kit shall contain sufficient silicone compound to lubricate metal parts and the housing for each assembly along with complete installation instructions.

- (a) All housings shall be made of water resistant synthetic rubber, suitable for burial in the ground or exposure to sunlight. Each housing shall form a water seal around the cable at the point of disconnection and between the insert body and enveloping Y housing.
- (b) All copper pins, sockets and fuse contacts shall have a minimum conductivity of 90 percent. The crimpable portion shall be fully annealed while the rest of the device is maintained in its original state.
- (c) Plastic sleeves shall be rigid, molded insulating plastic material of sufficient outside diameter to form a watertight fit with its related housing. Wall thickness shall be 0.10 in. (2.5 mm) maximum, and sleeve lengths of 4 and 7 in. (100 and 175 mm) shall be available.
- (d) All fuses shall be rated 600 volts, 100 000 amperes RMS interrupting capacity.

950.14.03 Connector Types. Each cable connector kit furnished shall be one of the following types:

- (a) Type I - Unfused, Quick Disconnect In Line Connector Kit containing:
 - (1) A copper pin crimpable to a conductor.

- (2) A receptacle having a centrally located, recessed locking socket constructed so that it is filled and retained by its housing and a disposable assembly pin.
 - (3) A plug housing for retention of the copper pin.
 - (4) A receptacle housing with disposable protective sleeve.
- (b) Type II - Fused, Quick Disconnect In Line Connector Kit containing:
- (1) A pair of spring loaded copper fuse contacts suitable for gripping the specified cartridge fuse. One contact shall be crimpable on a conductor and after insertion into its proper position within the load side plug housing, be capable of being securely retained therein. The other contact shall be preassembled for retention within the line side of the connector body.
 - (2) A load side housing permanently marked “Load Side”.
 - (3) A disposable assembly pin.
 - (4) A fuse of the specified ampere rating.
- (c) Type III - Fused, Quick Disconnect Y Connector Kit containing:
- (1) A pair of spring loaded copper fuse contacts suitable for gripping the specified cartridge fuse. One contact shall be crimpable on a conductor and after insertion into its proper position within the load side plug housing, be capable of being securely retained therein. The other contact shall be preassembled for retention within a Y insert body.
 - (2) A line side Y housing with two water seal cable ports.
 - (3) Two terminal lugs, each having a mounting hole.
 - (4) A bolt and a self locking nut.

(5) A Y insert body with preassembled line side fuse contact and a ring tongue terminal.

(6) A load side plug housing permanently marked “Load Side”.

(7) A disposable assembly pin.

(8) A fuse of specified ampere rating.

(d) Type IV - Unfused, Quick Disconnect Y Connector Kit containing:

(1) A copper pin crimpable to a conductor and suitable for retention in the load side receptacle housing.

(2) A Y insert body with preassembled load side copper socket and ring tongue terminal.

(3) A line side Y housing with two water seal cable ports.

(4) Two terminal lugs, each having a mounting hole.

(5) A bolt and self locking nut.

(6) A load side receptacle housing.