# DIVISION 900 – MATERIALS DETAILS

## SECTION 901 – PCC MATERIALS

[901, line 6]

####  (a) General

 ~~At the time c~~*C*ement ~~is~~ incorporated into the work~~, it~~ shall meet the quality requirements of these specifications.

[901, line 17]

 Different ~~kinds~~*types* or brands of cement, or cement of the same brand from different mills, even if tested, shall not be mixed during use unless allowed, and then only as directed. They shall not be used alternately in any one pour for any structure, unless otherwise approved.

####  (b) Portland Cement

 Portland cement shall conform to the requirements of the following ~~cited~~ specifications except as noted.

[901, line 31]

 a. The amount of pozzolan shall be limited to 20% ±5% by weight of the portland-pozzolan cement for ~~the~~ types IP and IP‑A.

[901, line 44]

 Portland cements and blended cements will be accepted based upon the manufacturer’s or ~~manufacturer/~~distributor’s documented ability to consistently furnish these materials in accordance with the applicable AASHTO requirements.

######  a. General Requirements

 Cements shall comply with the applicable requirements of 901 and will be accepted by certification from qualified manufacturers or ~~manufacturer/~~distributor*s*. The manufacturer is defined as the plant producing the cement. A manufacturer or ~~manufacturer/~~distributor shall become qualified by establishing a history of satisfactory quality control of cement produced as evidenced by results of tests performed by a testing laboratory which is regularly inspected by the Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology. Proof of such inspection shall be furnished upon request. All certifications shall be prepared by the manufacturer or distributor in accordance with the applicable requirements of 916. If a manufacturer or distributor elects to supply portland cement with a higher sulfur trioxide content in accordance with footnote B from Table 1 in AASHTO M 85, ~~it~~*they* shall supply all ~~of~~ the required supporting data to the Department’s Division of Materials and Tests prior to supplying such cement. A QPL of Cement Sources will be maintained by the Department.

 The manufacturer or ~~manufacturer/~~distributor shall conduct sufficient tests to ~~ensure~~*confirm* that adequate quality control is maintained and that cement furnished is in accordance with the specification requirements. Documentation pertaining to cement shipped on certification shall be maintained for a period of at least three years and shall be provided when requested.

[901, line 104]

 (1) For the initial qualifications, the manufacturer and distributor shall provide to the Department’s Division of Materials and Tests a QCP in accordance with the applicable requirements of ITM 806. The QCP shall also include the location and type of samples taken~~,~~ and a summary of complete test results from the proposed cement source. A current SDS shall be submitted as an integral part of the initial qualification package. The QCP shall explain the linkage between the cement being furnished and the manufacturer’s~~/~~ *or* distributor’s quality control data, relative to ship-loads, barge-loads, railroad car-loads, and other applicable loads.

 (2) Once the initial qualifications have been met, the manufacturer or distributor shall be required to furnish the cement test results for each shipment prior to Department cement usage for the first five cement shipments~~, which are~~ intended for Department use. The test results for all five of these cement shipments shall fully comply with the required material specifications. If not, this requirement will be continued for subsequent cement shipments until five consecutive cement shipment test results fully comply with the required material specifications, or Department source approval is withdrawn due to the inability to consistently supply satisfactory cement.

 (3) To maintain qualification after compliance with the previous requirements, a monthly submission of all cement shipment test results for cement ~~which is~~ intended for Department usage shall be submitted to the Department’s Division of Materials and Tests. If no cement shipments are received during a given month, the monthly submittal shall state “No cement was received during the month of \_\_\_\_\_\_\_\_\_\_, 20\_\_\_\_”.

######  d. Certification

 Only manufacturers and ~~manufacturer/~~distributors included on the QPL of Cement Sources may furnish cement on certification.

 A sample certification form addressing all ~~of the~~ required information is included in ITM 804. Alternate procedures and forms will be considered when requested~~,~~ and will be approved if there is a positive link between the cement furnished and the manufacturer’s quality control data.

[901, line 188]

 On days when fly ash is being ~~accumulated~~*produced* for use as a pozzolan, the supplier shall obtain a minimum of one sample per day and furnish test results for moisture content, loss ~~on~~*of* ignition, and No. 325 (45 µm) sieve residue for each sample.

[901, line 252]

 (2) For certification of test reports, the test results generated in accordance with 901.02(b)1 shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility~~,~~ and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving fly ash represented by these results.

[901, line 276]

####  (b) Acceptance Criteria

 Slag cement will be accepted based on the manufacturer’s or ~~manufacturer/~~ distributor’s documented ability to consistently furnish these materials in accordance with the applicable ASTM and AASHTO requirements.

[901, line 330]

 (1) For source approval, the supplier shall furnish a Certification, Other indicating the grade of slag cement, the name, location, and type of manufacturing facility. It shall state that the slag cement shipped for use on Department projects will be produced under appropriate quality control and shall be in accordance with the specified requirements. A sample certification form addressing all ~~of the~~ required information is provided in ITM 804.

 (2) For certification of test reports, the test results generated in accordance with 901.03(b) shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility~~,~~ and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving slag cement represented by these results.

[901, line 447]

 (2) For certification of test reports, the results generated in accordance with 901.04(b) shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility~~,~~ and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving silica fume represented by these results.

[901, line 523]

 They shall be single packaged dry mix requiring only water just prior to mixing. They shall be packaged in 40 to 60 lb bags with a ne~~a~~t yield of approximately 0.40 cu ft and shall allow at least a 50% extension, by weight with a 3/8 in. or a 1/2 in. round aggregate. The minimum shelf life shall be 12 months.

[901, line 589]

 The target water/cementitious ratio for the concrete mix design shall not exceed 0.435. The cement content and target water/cementitious ratio of the concrete mix design shall be sufficient to obtain the specified minimum 28-day compressive strength. Air-entraining admixture and chemical admixture Type A, B, C, D, or E from the QPL of PCC Admixtures and Admixture Systems may be used.

[901, line 600]

 The manufacturer shall provide for all testing and inspection services during each day’s production of the panels. The frequency of production control testing shall be based on a lot of 50 panels, or fraction thereof, for each day’s production. Sampling and testing of the plastic concrete shall be in accordance with 505.01, or the ASTM equivalent. A minimum of one water/cementitious ratio, ~~and~~ slump, air content, and relative yield tests shall be run per production lot, per day. A minimum of two 6 in. by 12 in. cylinders shall be cast per day’s production lot for compressive strength determination. Cylinders shall be cured in the same manner as the panels they represent. Relative yield, air content, and slump of the concrete shall be in accordance with 702.05. Compressive strength shall be determined in accordance with AASHTO T 22 or ASTM C39, with lot acceptance based on the average of 2 cylinders tested at an age no greater than 28 days. Panels shall not be shipped until the compressive strength meets or exceeds the 28 day requirement.

 If the cylinder-test results do not satisfy the requirements described herein, and additional cylinders for testing are not available, the manufacturer may core the panels. The wall manufacturer shall randomly select two panels from the lot for coring in accordance with AASHTO T 24 or ASTM C42. The wall manufacturer shall obtain one core on the backside of each panel with a device that produces uniform test samples without coring completely through the panel. Coring shall not be located within 6 in. of the panel fasteners or the edges of the panels~~,~~ and shall avoid the panel's reinforcing steel. The wall manufacturer shall fill the core holes with equivalent concrete materials or rapid setting patch materials, and trowel to produce a smooth finish. Excess material removed during troweling shall not be reused. If rapid setting patch material is used, mixing and curing shall be in accordance with the manufacturer's recommendations. Compressive strength testing shall be performed on the cores. If the average strength-test results from the cores satisfy or exceed the requirements described herein, the production lot panels may be shipped.

[901, line 666]

 Verification of ~~the~~ panel~~s~~ compressive strength~~s~~ will be conducted by the Engineer. The frequency of verification testing will be one test for every 750 panels per manufacturer with a minimum of one test per contract. One panel will be randomly selected and two locations will be selected for coring. In the presence of the Engineer, the Contractor shall obtain two 4 in. cores on the backside of the panel without coring completely through the panel. The Contractor shall refill the core holes with rapid setting patch materials and trowel to produce a smooth finish. Excess material removed during troweling shall not be reused. Mixing and curing of the patching materials shall be in accordance with the manufacturer’s recommendations.

 The Engineer will test the cores in accordance with AASHTO T 24. The verification test results will be averaged and shall be in accordance with 901.10(a)1a. If the initial verification test results do not satisfy the requirements described herein, the Engineer will randomly select two different panels for additional verification testing. If the additional verification tests satisfy the requirements described herein, no further action is required. If the test results still do not satisfy the requirements described herein, installation of panels shall cease and the Engineer will conduct an investigation. Panels manufactured on the same dates as the panels cored for verification tests that have already been installed will be considered and adjudicated as ~~a~~ failed material in accordance with 105.03. The Engineer will conduct verification testing until three consecutive dates of production satisfy the strength requirements described herein. The Contractor or wall manufacturer shall make arrangements so ~~that~~ panels from three consecutive dates of production are accessible for coring. Installation of panels may resume once acceptable verification testing results are achieved.

[901, line 718]

 All panels shall be handled, stored, and shipped ~~so as~~ to eliminate the danger of chipping, cracks, fractures, or excessive bending stresses. Panels in storage shall be supported on blocking located immediately adjacent to tie strips to avoid bending the tie strips.

## SECTION 902 – ASPHALT MATERIALS

[902, line 9]

 Performance graded asphalt binders shall be ~~supplied by~~*from* a supplier on the QPL of Performance-Graded Asphalt Binder Suppliers. A binder will be considered for inclusion on the QPL by following ITM 581.

[902, line 72]

 RS-2, HFRS-2, and SS-1h shall be in accordance with AASHTO M 140, except the cement mixing test is waived.

[902, line 81]

 The polymer modified asphalt emulsion shall be a quick-set, CSS-1h emulsion in accordance with AASHTO M 208, except the cement-mixing test is waived. The polymer material shall be milled or blended into the asphalt or blended into the emulsifier solution prior to the emulsification process. The minimum polymer solids content will be 3.0% based on the residual of the emulsion. Mix set additives shall be added as required to provide control of the quick-set properties. Additional requirements shall be in accordance with the following:

[902, line 158]

 a. bulk storage tanks from sampling valves located in the tank or line and asphalt plant storage tanks from sampling valves located in the tank*,*

 b. transports from sampling valves*,*

 c. distributors from valves*,*

 d. other storage or locations as approved*,*

 e. sampling by other recognized devices may be approved*, and*

 f. sampling valves beyond the in-line blending location.

[902, line 203]

 (m) Ductility of Binder Material, except that the conditioning period of the specimens may be shortened, and ~~that~~ only one normal test will be required. Shortened conditioning period: The specimen shall be allowed to cool in air for at least 30 minutes. It shall then be trimmed and placed in the water bath for a period of 60 to 90 minutes before testing. In case of failure or dispute, three normal tests will be required and specimens shall be conditioned as in AASHTO T 51.

[902, line 254]

 b. For AE-150 the mixture of stone and asphalt shall be mixed vigorously for 5 minutes and then allowed to stand for 3 h. At the end of this time, the mixture shall again be mixed vigorously for 5 minutes. At the end of the *second* mixing period, the mix shall be rinsed by running sufficient tap water at the side of the container to completely immerse the mix. The tap water shall then be poured off and the rinsing step repeated as necessary until the rinse water pours off essentially clear. The stone shall remain a minimum of 90% coated.

[902, line 301]

 2. **Test 2**. Approximately 500 g of produced mixture shall be heated to 250°F in a laboratory oven for 2 h~~;~~*,* stirred*,* and cooled to 200°F. ~~Then a~~*A* portion of the mix shall *then* be placed in boiling distilled water, quantity of mix and quantity of boiling water shall be as specified in Test 1, and stirred with a glass rod at the rate of one revolution per second for 3 minutes. The aggregate shall retain a minimum of 90% of its asphalt film compared with the remainder of the sample, upon completion of this procedure.

 Note: The purpose of these tests is to determine the relative compatibility of the aggregate and asphalt, and to detect tendency of Asphalt Emulsions to re-emulsify. ~~Test 2 may be performed as a method of determining whether compatibility can be achieved, Test 1 having given unsatisfactory results~~*If Test 1 returns unsatisfactory results, Test 2 may be performed as a method of determining whether compatibility can be achieved*.

## SECTION 903 – CLASSIFICATION OF SOILS

[903, line 4]

 All ~~of the~~ soils shall be tested and classified in accordance with AASHTO M 145, and in accordance with the grain-size classification procedure as follows:

## SECTION 904 – AGGREGATES

[904, line 49]

 (f) If it is determined that a new target is necessary, a request shall be made in writing to the ~~District Testing Engineer~~*DTE* to establish the new target.

[904, line 16]

 Fine aggregates for use in HMA shall be natural sand or crushed limestone, dolomite, gravel, sandstone, SF, or ACBF. SF sand may be used in HMA surface mixtures. SF sand may only be used in HMA base and HMA intermediate mixtures if SF in accordance with 904.01 is used to produce the SF sand. The amount of crushed limestone sand shall not exceed 20% by volume of the total aggregate used in HMA surface mixtures with ESAL *counts* equal to or greater than 3,000,000, except limestone sands manufactured from aggregates on the QPL of Polish Resistant Aggregate Sources will not be limited. If soundness testing cannot be conducted, the aggregate shall come from a Category I source in accordance with ITM 203.

[904, line 172]

 Sampling and testing shall be conducted in accordance with the following AASHTO and ITM~~s~~ *procedures*.

[904, line 199]

 The coarse aggregate shall comply with the quality requirements and the additional requirements in accordance with 904.03(a). ~~However, c~~*C*oarse aggregate may be rejected based on previous performance service records. Class AP is defined as the highest classification and Class F the lowest. Blending of material for compliance with gradation or crushed particle requirements may be approved when requested in writing. Blending of aggregate products to improve the quality classification of the finished product will not be allowed.

[904, line 210]

 The coarse aggregate angularity, CAA*,* of the total blended aggregate, including recycled materials, shall meet or exceed the minimum values for the appropriate ESAL category and position within the pavement structure as follows.

[904, line 255]

 c. ESAL Category 4 and type D surface mixtures. High friction aggregates including ACBF slag, SF slag, sandstone, or aggregates in accordance with ITM 221 shall be used and at a minimum shall comprise 50% by volume of the coarse aggregate.

[904, line 272]

 SF slag, sandstone, crushed dolomite*,* and polish resistant aggregates in accordance with 904.03(a) may be used in SMA mixtures provided the mixtures are designed in accordance with ITM 220.

[904, line 277, table, *see* notes row]

Notes: (1) The liquid limit shall not exceed 25 (35 if slag) and the plasticity index shall not exceed 5. The liquid limit shall be determined in accordance with AASHTO T 89 and the plasticity index in accordance with AASHTO T 90.

 (2) Includes the total amount passing the No. 200 (75 µm) sieve as determined by AASHTO T 11 and AASHTO T 27.

 (3) Decant may be *from* 0 ~~-~~*to* 2.5 for stone and slag.

[904, line 281]

 Sampling and testing will be in accordance with the following AASHTO, ASTM, and ITM~~s~~ *procedures*.

[904, line 334]

 Precast concrete riprap shall consist of unreinforced concrete units of the thickness specified and shall be in accordance with the details shown on the plans. The precast concrete units shall be in accordance with ASTM C139*,* except the fine aggregates shall be in accordance with 904.02(a) and the coarse aggregates, class A or higher, shall be in accordance with 904.03. The minimum compressive strength shall be 2,500 psi for an average of three units and 2,300 psi for individual units. The maximum water absorption shall be 12 lb/cu ft for an average of three units.

## SECTION 905 – MASONRY UNITS

[905, line 72]

 (c) Cast iron detectable warning surfaces shall be manufactured from gray iron in accordance with AASHTO M 105, Class No. 30A as a minimum. The truncated domes shall be as shown on the plans. The tops of the domes and the space between domes shall have a non-slip textured surface. The minimum thickness of the casting shall be 0.20 in. The minimum thickness shall not be measured within the area of integral reinforcing ribs or bracing, domes*,* or the textured surface.

[905, line 93]

 These units shall be cast in substantial permanent steel forms. Structural concrete shall attain a minimum 28-day compressive strength of 3,000 psi as determined in accordance with AASHTO T 22. When air-entrained concrete is specified, it shall have an air content of from 5% to 8% by volume. The precast units shall be cured in accordance with AASHTO M 170. Water absorption of individual cores taken from such units shall not exceed 9%. Additional reinforcement shall be provided as needed to handle the precast units.

## SECTION 906 – JOINT MATERIALS

[906, line 8]

(shown in alphabetical order)

|  |  |
| --- | --- |
| Property | Test Method |
| Asphalt Content | ASTM D545 |
| Compressive Strength | ASTM D8139 |
| Density | ASTM D545 |
| Extrusion | ASTM D545 |
| Freeze Thaw Resistance | ASTM D8139 |
| Heat Resistance | ASTM D8139 |
| Recovery | ASTM D8139 |
| Water Absorption | ASTM D545 |

[906, line 34]

 The sealants which are self-leveling shall be identified as such on the QPL of Joint Sealants, and will not require tooling. Sealants not identified as self-leveling on the QPL shall be tooled or applied ~~in such a manner which causes them~~ to wet the joint faces. ~~Such sealants which are not formulated for self-leveling will not position properly in the joint under its own weight~~*Sealants which are not self-leveling will not position properly in the joint under their own weight.* A backer rod as set out herein shall be used to control sealant configuration and facilitate tooling. ~~Applicable j~~*J*oint configurations shall be as shown on the plans. After a joint has been sealed, all surplus joint sealer on the pavement surfaces shall be promptly removed. Traffic shall not be allowed over sealed joints until the sealer is tack free.

[906, line 189]

 The joint assembly shall be preset by the manufacturer in accordance with the approved working drawings, joint setting data*,* and specifications. The assembly shall be properly secured for shipping and contain provision for final field adjustment at the time of installation. The manufacturer shall furnish a copy of the installation instructions prior to the placement of these joints.

[906, line 215]

 1. be held in place by compressive forces throughout the normal limits of joint movement~~;~~*,*

 2. be supplied and installed in one piece~~;~~*,*

 3. have corner locked edges for a watertight fit~~;~~*,*

 4. not be any part of the load bearing riding surface~~;~~*,*

 5. be installed using seal lubricant-adhesive or be mechanically clamped in position to produce a watertight seal~~;~~*,*

 6. have a shape which promotes self removal of foreign material during normal joint operation~~;~~*,*

 7. be recessed 1/2 in. below the riding surface throughout the normal limits of joint movement~~;~~*,*

 8. be held in position by the separator beams~~;~~*,*

[906, line 243]

 1. provide the riding surface across the joint~~;~~*,*

 2. have an extruded or machined shape suitable to hold the seals~~;~~*,*

 3. be stable against tipping, tilting, or lifting during application of traffic loads by use of a suitable shape and connection to the support bar~~;~~*,*

 4. be supported individually on their own independent support bars~~;~~*,*

 5. maintain equidistant spacing through use of suitable urethane equilibrium type control spacers to counter the compressive forces of the seals or through a positive horizontal mechanical linkage or proportioning bar.

 The support bars shall be in accordance with the requirements as follows:

 1. incorporate stainless steel sliding surfaces to minimize resistance to joint movements~~;~~*,*

 2. be supported above, below, and laterally as required to prevent lifting, to transmit bearing loads, and to maintain positioning of the bar.

## SECTION 907 – CONCRETE, CLAY, AND PLASTIC DRAINAGE COMPONENTS

[907, line 56]

 Precast concrete units shall be from a source listed in the QPL of Certified Precast Concrete Producer~~,~~ in accordance with ITM 813.

[907, line 62]

 In addition to the requirements of AASHTO M 199, the manhole steps shall be permanently marked with the specific step designation~~,~~ and the manufacturer’s identification. This marking shall remain exposed after installation.

 Steps shall be selected from the QPL of Manhole Steps. Requests for adding steps to the QPL shall be accompanied by: (items placed into list)

 *(a)* a certified test report demonstrating compliance with AASHTO M 199~~;~~*,*

 *(b)* instruction for proper installation~~;~~*,*

 *(c)* complete product description including the ancillary equipment required for installation~~;~~*,* and

 *(d)* a sample step.

 (shown as separate paragraph) The Department may perform a laboratory evaluation of specific steps and may not add steps to the QPL which are not furnished with ancillary installation equipment.

[907, line 86]

 The section ends shall be ~~of such design~~*designed* and ~~shall be so~~ formed ~~that~~*so* when the structure sections are erected, they shall make a continuous line of structure with a smooth interior free of irregularities. The ends of the structure sections shall be normal to the walls and centerline, except where beveled ends are specified. The surface of the structure sections shall be cast from a smooth steel form or troweled surface. Trapped air pockets causing surface defects shall be considered as part of a smooth steel form finish.

[907, line 106]

 Precast concrete units shall be from a source listed on the QPL of Certified Precast Concrete Producers~~,~~ in accordance with ITM 813. A water-reducing admixture from the QPL of PCC Admixtures and Admixture Systems may be used.

[907, line 128]

 Bolts and studs shall be hot dipped in accordance with 910.02(g)1. Nuts shall be in accordance with ASTM A563, grade A, Hex style~~;~~*,* unless specified otherwise. Washers shall be in accordance with ASTM F844, unless specified otherwise. Bolts, nuts*,* and washers shall be hot dip zinc coated.

[907, line 187]

 The bituminous material shall adhere to the concrete or clay pipe ~~so as~~ to make a watertight seal and shall not flow, crack, or become brittle when exposed to the atmosphere.

[907, line 204]

 Pipe joint mortar shall consist of 1 part portland cement and 2 parts sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after ~~its~~ preparation.

## SECTION 908 – METAL PIPE

[908, line 42]

 The fabricator shall certify, on furnished forms that:

 (a) the fabricated structure has been manufactured in accordance with these Standard Specifications~~;~~*,*

 (b) based on the sheet manufacturer’s certified mill report, the materials used in fabricating the structure were tested and the test results are in accordance with the specified requirements~~;~~*,* and

 (c) copies of the sheet manufacturer’s certified mill report shall be on file and available to review for five years.

[908, line 75]

 End sections consisting of multiple panels shall have lap seams ~~which shall be~~ tightly jointed with 3/8 in. galvanized rivets or bolts.

 All steel pipe end sections shall have a ~~toe plate anchor constructed of~~ 0.138 in. thick galvanized steel *toe plate anchor*. The toe plate anchor shall be match punched to fit holes in the skirt lip, and shall be supplied loose, and complete with 3/8 in. diameter galvanized bolts.

[908, line 88]

 The material, fabrication, the manufacturer’s certified mill report, and *the* fabricator’s certification shall be in accordance with the applicable requirements of 908.02. Coupling bands shall be fully bituminous coated.

[908, line 97]

 The asphalt material for coating shall be in accordance with 902.01(e). Samples of the asphalt material will be obtained from the working tank prior to or during coating of the pipe, or from strippings off the pipe after coating. ~~When~~*Asphalt materials* applied to the pipe~~, the asphalt material~~ shall be free from impurities. The metal shall be free from grease, dust, or moisture. Either process set out below may be used for application.

## SECTION 909 – PAINT AND LIQUID EPOXY

[909, line 20]

 Paints and coatings shall be delivered in new containers of such strength, durability, design, fabrication, and material that the paint shall be suitably protected in transit and in storage against any change in characteristics which would cause rejection *based* on ~~the basis of~~ laboratory or field evaluation. Each container shall bear a label which shows the name and address of the manufacturer, kind of paint or coating, formula identification, date of manufacture, and lot or batch number. The container shall be ~~so~~ filled ~~that~~*so* the net weight of the material in the container ~~shall~~*equals* be the product of the weight per gallon at 77°F and the stated number of gallons in the container.

[909, line 56

 Organic zinc primer shall be a self-curing ~~type~~ primer. It shall be in accordance with SSPC Paint Specification No. 20, Type II. The organic zinc primer shall be compatible with inorganic zinc and finish coat paints already on the bridge. The color shall be able to produce a distinct contrast with blast cleaned metal surface and the finish coat. The cured organic zinc film shall be compatible with a top coating of waterborne finish coat paint.

[909, line 172]

 The vehicle shall consist of an acrylic emulsion together with the necessary antifoamers, cosolvents, coalescing agent, preservatives, and antifreeze ~~in order~~ to produce a coating in accordance with this specification.

[909, line 244]

 This coating system shall consist of an inorganic zinc primer, an epoxy intermediate paint, and a polyurethane finish coat for the painting of steel bridges and other structural steel. All ~~of the~~ coatings within any coating system shall be manufactured by the same manufacturer and shall be compatible with one another. All coatings shall be in accordance with 909.02.

[909, line 257]

 The coating system shall be evaluated by the NTPEP Structural Steel Coatings Program. The certified report from NTPEP shall include specific identification of the formulation or system being submitted for consideration. It shall also include all test results for the specific coating formulation or coating system. The certified report from NTPEP will be accepted as the certified test report required for approval. The coating system shall be in accordance with all ~~of the~~ applicable acceptance criteria contained within 909.02. In addition, the finish coat shall maintain a minimum of 60% specular gloss retention relative to the initial gloss and a maximum color change of 6 ΔE for Test No. 3, Cyclic Weathering Resistance.

[909, line 307]

 The paint shall not darken under the heating conditions of application~~,~~ or show appreciable discoloration due to sunlight exposure and aging of the paint lines. The paint shall be furnished ready for use without thinning, screening, or other modifications and shall not settle, cake, curdle, liver, gel, or have an excessive change in viscosity in the container during a period of one year after manufacture. The paint shall be capable of being stirred to a uniform consistency. The paint shall be able to withstand variations of temperatures when stored outside in the containers as delivered, and in an environment above 40°F. All paint furnished under these specifications will be rejected if it contains skins, thickened or jelly-like layers, lumps, coarse particles, dirt, or other foreign materials which prevent the proper application of the paint, or produces a non-uniform paint line. All paint which cannot be transferred by pumps on the paint equipment from the shipping containers and through the paint equipment due to excessive clogging of screens, filters, or paint guns will be rejected.

 The paint shall dry to a no-tracking condition in less than 60 s. The no tracking condition shall be determined by actual application of the paint on the pavement at a wet film thickness of 15 mils with glass beads at a rate of 6 lb/gal. The paint lines for the determination of no-tracking condition shall be applied with the specialized painting equipment operated ~~so as~~ to have the paint at application temperatures up to 140°F at the spray guns. This maximum no tracking time shall not be exceeded when the pavement temperature varies from 50 to 120°F, and with all relative humidity conditions providing that the pavement is dry. The no tracking time shall be determined by passing over the paint line 60 s after the paint application, in a simulated passing maneuver at a constant speed of 30 to 40 mph with a passenger car. A paint line with no visual deposition of the paint to the pavement surface when viewed from ~~a distance of~~ approximately 50 ft from the point where the vehicle crossed the paint line shall be considered as showing a condition of no tracking and being in accordance with the requirement.

#####  1. Composition Requirements

 The exact composition of the waterborne traffic paint shall be left to the discretion of the manufacturer, provided that the finished product is in accordance with ~~all of~~ the specification requirements.

[909, line 386]

###  909.11 Epoxy-Resin-Base System for Bonding Plastic Concrete to Hardened Concrete

 Two-component, epoxy-resin bonding systems for use in bonding freshly mixed concrete to hardened concrete shall be in accordance with ASTM C881 for type II, grade 2, and the class consistent with the ambient temperature as follows. Class A for use below 40°F~~;~~*,* class B for use between 40°F and 60°F~~;~~*,* and class C for use above 60°F. A type C certification in accordance with 916 shall be provided for the epoxy-resin-base system.

###  909.12 Epoxy Resin Additives for Injection into Concrete

 The epoxy resin adhesive shall be of low enough viscosity ~~such that~~*so* it flows to the next open port in the surface seal material. The adhesive shall be capable of penetrating crack widths down to 0.005 in. The adhesive shall be capable of bonding to dry or damp surfaces. The adhesive shall exhibit a slant shear strength exceeding the concrete strength when tested fully cured in accordance with AASHTO T 237.

## SECTION 910 – METAL MATERIALS

[910, line 91]

#####  8. Steel Spiral Reinforcement

 Steel spiral reinforcement shall be either:

 a. deformed billet steel, ASTM A615, grade 60~~;~~*,* or

 b. cold drawn steel wire, ASTM A1064.

[910, line 107]

 a. the bars shall be in accordance with 910.01(b)1~~;~~*,*

 b. the coating color shall contrast with the color of iron oxide~~;~~*,*

 c. tensile and bend tests shall be performed on the bars. If an examination of the bend test specimen suggests the need, the adhesion of the coating shall be checked by subjecting additional specimens to the 120° bend test. Hairline cracks without bond loss will be acceptable provided there are not more than two and the length of either crack does not exceed 1/4 in. The average coating thickness shall be 9 to 14 mils after cure. The thickness measurements shall be made in accordance with ASTM D7091. The coating thickness shall be an average based on 12 individual readings. No specific correction for the base preparation process shall be applied to the thickness measurements~~;~~*,*

 d. epoxy coated reinforcing bars furnished by coaters on the QPL of Reinforcing Bar and WWR Epoxy Coaters shall be accompanied by the types of certifications specified in ITM 301 and in accordance with 916~~;~~*,*

 e. repair and handling procedures shall be in accordance with 703.04. The patching material shall be in accordance with ASTM D3963.

[910, line 176]

####  (c) High Strength Structural Steel

 ~~This steel, w~~*W*hen specified, *this steel* shall be in accordance with ASTM A709, grade HPS 100W; ASTM A709, grade 50; or ASTM A709, grade 50W.

[910, line 362]

###  910.05 Castings

 The casting design shall be proof loaded to 178 kN in accordance with AASHTO M 306. Castings shall be in accordance with the plan dimensions and to the following requirements for the designated materials. A certified inspection report shall be submitted by the manufacturer with each shipment of castings, except as otherwise provided herein. Inspection and testing shall be done by the manufacturer. The certified inspection report shall list the casting number, ~~and~~ the type of material, including the class of gray iron, and the grade of ductile iron. It shall state that inspection and testing has been performed, that all parts shipped meet the pertinent specification requirements, and that all component parts fit. The supporting test results, including proof load data, shall be retained and be available on request for a period of seven years. All castings shall have the manufacturer’s identification and the date of manufacture cast on an exposed surface.

[910, line 426]

 Blowholes appearing on finished castings shall be located so that a straight line laid in any direction does not cut a total length of cavity greater than 1 in. in any 1 ft *length.*~~nor shall any~~*No* single hole exceed 1 in. in any dimension or have an area greater than 1/2 sq in. Blowholes shall not be deep enough to affect the strength of the casting adversely.

[910, line 440]

####  (a) Bronze Castings

 Bronze castings shall be in accordance with ASTM B22, alloys C91100 or C91300. A type A certification in accordance with 916 shall be provided for bronze casting. In addition to the number of casting*s* or total weight, the results of the following shall be shown on the certification.

[910, line 477]

#####  3. Connector Bar

 The connector bar, if used, shall be fabricated of cold-drawn steel wire in accordance with ASTM A1064, and galvanized, if ~~so~~ shown on the plans, in accordance with ASTM A641, class 5 or class C.

[910, line 487]

 Wire-facing shall be smooth steel WWR in accordance with 910.01(b)5. Galvanization, if required, shall be in accordance with ASTM A1060. All wire-facing shall be handled, stored, and shipped ~~so as~~ to eliminate the danger of excessive bending stresses. The Engineer will test samples in accordance with ASTM A1064.

[910, line 605]

 Construction details shall be as shown on the plans. Whenever *approved* field fabrication~~, as approved,~~ requires cutting or drilling, the cut or drilled member shall be coated with a high zinc dust-zinc oxide paint conforming to the requirements of Federal Specification TT-P-641, or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied.

[910, line 624]

 1. Post brackets, bars, plates and shapes for bridge railing brackets, and plate washers shall be in accordance with ASTM A36. Post brackets, bars, and plates and shapes for bridge railing brackets shall be galvanized in accordance with 910.10(a). Plate washers shall be galvanized after fabrication in accordance with ASTM A153. The weight of the W6 x 15 post bracket*s* shall be in accordance with 910.10.

[910, line 658]

 6. For breakaway cable terminal~~,~~ and cable terminal anchor system*s*, the rail element*s*, standard bolts, nuts, and washers shall be in accordance with 910.09 and requirements 1 and 3 of 910.11(a).

 7. For cable terminal anchor system, the anchor bracket, end plate, soil plate, bearing plate, strut and yoke shall be in accordance with AASHTO M 270, grade 250. They shall be zinc coated after fabrication in accordance with AASHTO M 111. The steel tube shall be in accordance with ASTM A500, grade B and zinc coated in accordance with AASHTO M 111. The post sleeve shall be in accordance with ASTM A53, grade B and zinc coated in accordance with AASHTO M 111. The stud shall be in accordance with ASTM A307~~,~~ and zinc coated in accordance with AASHTO M 111. The threads shall be in accordance with ANSI B1.13M and shall be M24 by 3, class 6g pitch. The swaged fitting shall be in accordance with ASTM A576, grade 1035, zinc coated in accordance with AASHTO M 111, and shall be annealed for cold swaging. A lock pin hole to accommodate a 1/4 in. plated spring-steel pin shall be drilled through the head of the swaged fitting.

[910, line 684]

 High strength heavy hex bolts shall be in accordance with ASTM F3125, grade A325 or ASTM A449. High strength heavy hex nuts shall be in accordance with ASTM A563 Bolts, nuts, and washers shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. Foundation plates and bearing plates shall be in accordance with ASTM A36~~,~~ and shall be galvanized after fabrication in accordance with ASTM A123, except the weight of zinc coating per square foot of actual surface shall average no less than 2.0 oz and shall be no less than 1.8 oz for any individual specimen. Welding shall be in accordance with AWS D1.1.

[910, line 704]

 Tapered washers may be of steel or malleable iron~~,~~ and galvanized in accordance with ASTM A153.

[910, line 763]

#####  1. Group 1

 Tubular steel fence posts for group 1 shall be hot-dipped zinc-coated and shall be in accordance with ASTM F1083*,* except tests shall be conducted on sample posts selected as ~~being~~ representative of the posts furnished. The weight per foot will be acceptable provided it is at least 90% of the specified weight.

#####  2. Group 2

 Tubular steel fence posts for group 2 shall have a minimum 50 ksi yield strength and be in accordance with AASHTO M 181, except that the inner pipe surface may be galvanized in lieu of a zinc rich coating or hot dipped aluminum coated, Type 2, meeting the chemical requirements of AASHTO M 274. The aluminum coated, Type 2, steel fence posts shall be manufactured by roll forming aluminum coated, Type 2, steel strip and electric resistance welding it into tubular form. The outside of the weld area shall be metallized with commercially pure aluminum to a thickness sufficient to provide resistance to corrosion equal to that of the remainder of the outside of the post. The aluminum coating weight (mass) shall be a minimum of 0.75 oz/sq ft average, and 0.70 oz/sq ft for an individual test specimen~~,~~ as measured in accordance with ASTM A428. Specimens for determining weight of coating shall be obtained in accordance with ASTM F1083.

[910, line 845]

 The finished posts shall be machine straightened and have a smooth uniform finish free from cracks, flaws, injurious seams, laps, blisters, and edges which are ragged, sharp, and imperfect, or other defects affecting their strength, durability, or appearance. The maximum variation in straightness shall be no more than 1/4 in. in any 5 ft of length~~,~~ or exceed in inches 1/4 times the number of feet of length divided by 5. Bolt holes of the diameter specified shall be accurately spaced vertically and centered horizontally so that holes will register for back to back application. All holes and sheared ends shall be commercially free from burrs.

[910, line 869]

 Steel posts shall be wired or strapped securely in bundles of not more than 2,000 lb. They shall be nested in rows with the edges intermeshed ~~so as~~ to form a rectangular bundle and shall be fastened in such a manner that they do not slip or rub against each other and cause damage to the finish. Care shall be taken during shipment to prevent the bundles from rubbing against each other and causing damage. Excessive damage to the finish during shipment will be cause for rejection of the damaged posts.

#####  2. Deflection Test Requirements

 Posts will be tested as a simple beam with the flange in compression on non‑restricting supports 24 in. apart. Test specimens shall be 28 in. ±1/4 in. long. A load of 1,500, 3,500, or 4,600 lb, depending on the type of post, shall be applied at the center of the span with a mandrel of not less than 1 in. in diameter. Application of the load shall be at a speed ~~of~~ not to exceed 0.03 in. per minute. Deflection of the post upon application of the total load shall not exceed 0.16 in. The load shall then be removed. Deflection of the post 1 minute after removal of the load shall not exceed 0.01 in.

[910, line 1087]

#####  1. Tension Wire

 Tension wire intended for use on the top or bottom of steel chain link fence or on the bottom of farm field fence*,* when specified*,* shall be spring coil or crimped steel wire with an initial diameter of 0.177 ±0.005 ~~of an~~ in., a minimum breaking load of 1,950 lb, and a coating of either zinc or aluminum. The minimum weight (mass) of coating shall be 0.80 oz/sq ft for galvanized wire and 0.40 oz/sq ft for aluminum coated steel wire. The weight of aluminum coating shall be determined in accordance with ASTM A428.

[910, line 1164]

#####  1. Steel Gates

 Steel gate posts shall be standard weight, galvanized, steel pipe in accordance with ASTM F1083 and furnished with all necessary fittings. Post sizes shall be as set out above. The gate frames shall be of standard weight, galvanized, steel pipe in accordance with ASTM A53~~;~~*,* of 1 1/2 in. (38.1 mm) nominal size~~;~~*,* and shall have welded joint or riveted construction using galvanized pressed steel or malleable fittings. Areas welded after galvanizing shall be coated with a material conforming to the requirements of Federal Specification TT-P-641, type II or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied. Fabric coverings for gates shall be in accordance with 910.18(a) or 910.18(b). These gates shall be furnished with necessary fastenings, hinges, center stops, and locking devices galvanized after fabrication in accordance with ASTM A153.

[910, line 1199]

 Strain poles for cable span signs shall be in accordance with 922.10(a). Each strain pole shall include three band-type attachments for span wire clamps. Such attachments shall be galvanized in accordance with ASTM A153. Cable shall be in accordance with 922.10(e)2. Each cable shall include three wire rope clips at each end. Anchor bolts shall be in accordance with 922.10(c)5. All sign mounting hardware*,* except for the extruded aluminum bar*,* shall be galvanized in accordance with ASTM A153.

[910, line 1214]

####  (a) Aluminum Trusses for Overhead Sign Structures, Box Truss and Dynamic Message Sign Structure Truss

 Extruded tubes and other shapes shall be of aluminum in accordance with ASTM B221, B241, or B429, alloy 6061-T6. All other castings shall be of aluminum in accordance with ASTM B26, alloy 356.0-T6. Gusset, flange*,* and stiff*e*ner plates shall be of aluminum in accordance with ASTM B209, alloy 6061-T6. Plates shall be free of sharp edges and irregularities.

 Bolts, nuts, screws, and flat washers shall be passivated type 304 stainless steel. Bolts and screws shall be in accordance with ASTM A193, grade B8. Hexagon nuts and washers shall be in accordance with ASTM A194, grade 8. High strength bolts, nuts*,* and washers for chord splice connections, with matching lock nuts having steel inserts, shall be in accordance with 910.02(g) and shall be galvanized in accordance with AASHTO M 232, class C or D.

[910, line 1248]

####  (b) Steel Overhead Sign Structures, Cantilever, Monotube, Tri-Chord, Bridge Attached, and End-Supports for Box Truss and Dynamic Message Sign Structure

 End-support members for box truss and dynamic message sign structure shall be fabricated from constant cross-section tubular steel or extruded steel shapes as indicated on the drawings. Sections used for end-support columns, diagonal and horizontal members shall be constant cross-section tubular members in accordance with ASTM A53, type E or S, grade B, minimum yield strength of 35,000 psi. Constant cross-section tubular steel with greater yield strength may be used with written approval*.*~~, however, s~~*S*tructural dimensions shall remain as shown on the plans. Sections used for cross support beams shall be constant cross-section extruded W-shapes in accordance with ASTM A709, grade 36. Base plates shall be in accordance with ASTM A36. Base plates for columns shall develop the full strength of the columns. Structures shall be galvanized after fabrication in accordance with ASTM A123.

 Support columns for the cantilever structure shall be fabricated from constant cross-section tubular steel as indicated on the drawings. Column sections shall be in accordance with ASTM A53, type E or S, grade B as shown on the plans. Members shall have minimum yield strength of 35,000 psi. Constant cross-section tubular steel with greater yield strength may be used~~,~~ with written approval*.*~~, however, s~~*S*tructural dimensions shall remain as shown on the plans. Base plates shall be in accordance with ASTM A36. Base plates shall develop the full strength of the columns.

 Cantilever arms shall be either double arms or quadri-chord trusses as shown on the plans.

 Cantilever arms shall be fabricated from octagonal tubular member with 0.14 in./ft taper and in accordance with ASTM A595, grade A or B, or ASTM A572, grade 50. Quadri-chord arms shall be of constant cross-section tubular members in accordance with ASTM A53, type E or S, grade B as shown on the plans. Members shall have minimum yield strength of 35,000 psi. Steel with greater yield strength may be used~~,~~ with written approval*.*~~, however, s~~*S*tructural dimensions shall remain as shown on the plans. Structures shall be galvanized after fabrication in accordance with ASTM A123. Plates shall be free of sharp edges and irregularities.

 High strength bolts, nuts*,* and washers for chord to column connections, with matching lock nuts having steel inserts, shall be in accordance with 910.02(g) and shall be galvanized in accordance with AASHTO M 232, class C or D.

[910, line 1291]

 Bridge attached structures shall be fabricated from constant cross-section tubular steel in accordance with ASTM A53, type E or S, grade B with a minimum yield strength of 35,000 psi. Constant-cross section tubular steel with greater yield strength may be used, with written approval. ~~However, s~~*S*tructural dimensions shall remain as shown on the plans. Structures shall be galvanized after fabrication in accordance with ASTM A123.

[910, line 1325]

 Strain poles shall be anchor bolt type complete with hand-holes and pole top or cap. They shall meet the requirements set out above for cantilever sign structures. Each pole is to include three band-type attachments for span wire clamps. The band shall be from material in accordance with ASTM A572~~,~~ grade 50~~;~~*,* ASTM A606~~;~~*,* or approved equal. The bands shall not be of the U-bolt type. The poles shall have maximum deflections as shown below when loaded 18 in. from the top with a 100 lb load.

[910, line 1379]

 (f) Steel washers shall be standard round cut or lock washers~~,~~ as shown on the plans.

[910, line 1400]

 A type C certification in accordance with 916 shall be provided for the steel bridge railing components *with the exception of bolts*.

## SECTION 911 – WOOD MATERIALS

[911, line 5]

####  (a) General

 Untreated lumber is a ~~saw mill~~*sawmill* product which may be further manufactured by sawing, resawing, passing lengthwise through a standard planing machine, drying, cross cutting to length, and machining but is not treated with preservatives.

[911, line 23]

#####  4. Sawn Timbers

 *Timber is* ~~S~~*s*olid sawn pieces with a nominal dimension of 5 in. or more in the least dimension ~~is timber~~. Timbers may be classified as beams, stringers, posts, caps, sills, girders, or purlins. Timber for structural purposes shall be no less than 6 in. in width or thickness. Dimensions and grade of timber shall be as shown on the plans or as otherwise specified.

[911, line 36]

#####  6. Yard Lumber

 *Yard lumber is* ~~L~~*l*umber of all sizes and patterns intended for general building purposes ~~is yard lumber~~. The grading of yard lumber is based on the intended use of the particular grade and is applied to each piece with reference to its size and length when graded without consideration to further manufacture.

#####  7. Surfaced or Dressed Lumber

 ~~This is l~~*L*umber that is dressed by running it through a planer.

#####  8. Rough Sawn Lumber

 ~~This is l~~*L*umber that has been sawn, edged, and trimmed, but not dressed.

[911, line 81]

####  (c) Inspection

 *Regardless of grade markings* ~~A~~*a*ll lumber ~~regardless of grade markings~~ may be inspected for grades and quality at the point of origin or final destination. If, during inspection of a lot of lumber, it becomes apparent that the quantity of rejection~~s~~ exceed*s* 20%, the entire lot may be rejected.

####  (d) Tolerances

 Tolerances for rough sawn~~,~~ or dressed lumber shall be in accordance with the National Lumber Grades Authority Grade Rule standards for each species.

####  (e) Untreated Piling

 Untreated piles shall be in accordance with ASTM D25 and the following. All piling shall be cut from white or red oak, dense southern yellow pine, fir, or cypress, *and is* preferred in the order listed. They may be of other species, subject to approval, which can withstand driving without showing excessive brooming or splitting.

[911, line 134]

####  (c) Piling

 Timber piling, before treatment, shall be in accordance with 911.01(e)*,* except piles shall be southern yellow pine or Coastal Douglas-fir. The outer and inner bark shall be removed before treatment. Unless otherwise specified, piling shall be treated with a preservative in accordance with the applicable requirements of AWPA Standards T1 and U1, Commodity Specification E: Round Timber Piling, use category UC4C.

[911, line 164]

#####  1. Species and Grades

 Timber posts shall be of the species listed~~,~~ and shall be in accordance with the grading requirements specified in Table A. Timber blockouts shall be of the species listed~~,~~ and shall be in accordance with the grading requirements specified in Table B. Timber posts and blockouts shall have ~~the~~ cross-section*s* and length dimensions as shown on the plans.

[911, line 216]

######  b. Inspection Before Treatment

 The treater shall be responsible for ensuring that the material has the required approved grading agency stamp before treatment is commenced. The stamp or marking shall be applied on a wide face at the trimmed end. The stamp shall be applied ~~such that it~~*and*remain~~s~~ readable after treating. Material that has been air dried or kiln dried shall be inspected for moisture content in accordance with AWPA Standard M2.

[911, line 244]

######  h. Inspection During Treatment

 The treater shall determine that the preservatives used are in accordance with the requirements herein. The minimum frequency of the preservation analysis shall be each charge for the occasional single charge inspected. The minimum frequency for consecutive treatments from the same working tank shall be the first and at least one of every five additional charges, selected at random. Preservative samples shall be taken as appropriate ~~so as t~~o be representative of the solution in the treating cylinder.

[911, line 274]

######  m. Conformance

 The treating plant supplying the material shall be responsible for and will be required to supply a certificate indicating the species, grade, preservative type, retention, year, and name of treater. The certificate shall also include all of the other information ~~which is~~ listed in AWPA Standard M2, section 6.2.

[911, line 292]

#####  4. Field Treatment of Posts and Blockouts

 Cuts, holes, or injuries to the surface of posts and blockouts which occur after pressure treatment shall be field-treated with copper naphthenate in accordance with AWPA Standard M4.

#####  5. Rejection for Degrade After Treatment

 Guardrail posts or blockouts developing the following degrade prior to installation will be rejected regardless of prior approvals.

 a. single checks greater than 3 in. deep or checks opposite each other totaling more than 3 in. deep, measured with a probe not more than 1/16 in. thick~~;~~*,*

 b. single checks 1/4 in. wide or wider measured at the widest point, and extending more than 1/3 of the length of the post or blockout~~;~~*,*

 c. single checks greater than 3/8 in. wide measured at the widest point~~;~~*,*

 d. splits greater than 3 in. long which are in the plane of the bolt hole~~;~~*,*

 e. crooks or bows exceeding 1 in. per 10 ft length; and all twists~~;~~*,*

 f. combinations of checks, splits, or shakes which are otherwise in accordance with the specifications but which may cause the post or blockout to separate into several pieces.

## SECTION 912 – CONCRETE CURING MATERIALS AND ADMIXTURES

[912, line 6]

####  (a) Burlap Cloth made from Jute or Kenaf

 This material shall be new~~,~~ or reclaimed and thoroughly vacuum cleaned burlap. Burlap from sugar, salt, or fertilizer bags shall not be used. The burlap shall weigh no less than 10 oz/sq yd and shall be in strips of not less than 40 in. or more than 120 in. wide and no less than 2 ft longer than the width of the pavement being cured.

[912, line 30]

 Products may be added to the QPL of Liquid Membrane Forming Curing Compounds by completing the requirements in ITM 806, Procedure F. Testing shall be performed by a recognized independent laboratory approved by NTPEP. ~~In order t~~*T*o maintain approval, the manufacturer shall submit an annual recertification letter to the Department by January 1 of each year. The manufacturer shall also submit a type A certification for a single batch every four months to the Department’s Division of Materials and Tests.

[912, line 102]

####  (a) Air*-*Entraining Admixtures

 Air*-*entraining admixtures are materials to be added to PCC mixtures at the mixer for the purpose of entraining air.

[912, line 131]

#####  6. Type F

 Type F is a high range water reducing ~~admixture,~~ HRWR~~,~~ *admixture* that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater.

#####  7. Type G

 Type G is a high range water reducing and retarding ~~admixture,~~ HRWRR~~,~~ *admixture* that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater~~,~~ and retards the setting of concrete.

[912, line 164]

 3. Test reports shall not be more than five years old on January 1 of the approval year. New submittals of test reports more than five years old will be accepted~~,~~ if all subsequent five year limited retest reports~~,~~ are submitted. Subsequent limited retest results shall comply with the dating and age requirements specified above and shall include the following tests as a minimum requirement for compliance:

 a. infrared analysis, residue by oven drying, and specific gravity~~;~~

 b. water content and time of setting~~;~~

 c. flexural strength at 3, 7, and 28 days~~;~~

 d. relative durability.

[912, line 207]

 Synthetic, non-metallic~~,~~ fibers are used for concrete three-dimensional reinforcement to promote post-crack control~~,~~ and improve the long-term performance of PCC. Synthetic fibers shall be introduced into PCC mixtures at a minimum dosage rate of 4.0 lb/cu yd at the batching plant or a ready-mix truck.

[912, line 233]

 Testing of fiber-reinforced concrete shall be performed by a recognized independent commercial laboratory~~,~~ *and* regularly inspected by the CCRL for PCC materials~~,~~ to ensure that the properties of the fiber-reinforced concrete are in accordance with the following:

## SECTION 913 – SOIL TREATMENT MATERIALS

[913, line 3]

###  913.01 Water

 Water shall be clean and free of oil, algae, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Where the source of water is relatively shallow, the intake shall be ~~so~~ enclosed ~~as~~ to exclude silt, mud, grass, or other foreign materials. Water shall be tested in accordance with the test methods listed in the table below. To be acceptable for use, the results of the water testing shall be in accordance with the *following* results ~~as follows~~:

## SECTION 914 – ROADSIDE DEVELOPMENT MATERIALS

[914, line 11]

 Topsoil shall have a pH value of 6.2 to 7.4. Testing for pH value shall be performed in accordance with AASHTO T 289. Agricultural limestone may be added to topsoil ~~in order~~ to raise the pH to meet specification requirements. The addition of agriculture limestone shall be determined based on tests performed by a laboratory qualified by the Department. Topsoil shall not be incorporated into the work until it is approved.

###  914.02 Temporary Seed

 Temporary seed will be subject to approval prior to use by visual inspection of the Engineer. Temporary seed may be purchased from any commercial source provided the seed’s package is clearly marked and labeled by the manufacturer ~~as to~~ *with* its content and weight.

[914, line 57]

 Seed will be considered ~~to be~~ expired 15 months after the date it was tested. Expired seed shall not be installed.

 Each bag or container of seed shall have a printed tag or label providing all ~~of~~ the information required by IC 15-15-1-32. Seed from bags with no labels, illegible labels, or with labels not ~~giving~~*providing* all ~~of~~ the required information will not be accepted.

[914, line 72]

 Seed which meets the weed seed tolerance~~,~~ but does not comply with the purity or germination requirements, or both, may be used provided the percentage of purity or the percentage of germination is not more than 10% below the minimum specified and that the result obtained from the following formula~~e~~ does not exceed the maximum percent of weed seeds allowed.

[914, line 96]

(centered) Amount to be used = Amount specified x P x G

[914, line 109]

 Mulch for seeding may consist of straw~~;~~*,* excelsior mulch~~;~~*,* wood cellulose fiber mulch~~;~~*,* excelsior blanket~~;~~*,* paper mat~~;~~*,* or straw mat. All mulch shall be reasonably free from primary noxious weeds in accordance with 914.04.

#####  1. Excelsior Mulch

 Excelsior mulch shall consist of wood fibers cut from sound green timber. The average length of the fibers shall be 4 in. to 6 in. The cut shall be made ~~in such a manner as~~ to provide maximum strength of fiber, but at a slight angle to the natural grain of the wood ~~so as~~ to cause splintering of the fibers when weathering ~~in order~~ to provide adherence to each other and to the soil.

#####  2. Wood Cellulose Fiber

 Wood cellulose fiber mulch shall be made from wood chip particles manufactured particularly for discharging uniformly on the ground surface when disbursed by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed, and fertilizer when allowed, to form a homogeneous slurry. The mulch fibers shall intertwine physically to form a strong moisture holding mat on the ground surface. The mulch shall be heat processed ~~so as~~ to ~~contain no~~*prevent* germination or growth inhibiting factors. It shall be non-toxic and colored green. The percent of moisture content shall be determined in accordance with 621.14(c), except material containing more than 15% will be rejected. The ash content shall not exceed 1.5%. One hundred grams of oven dried material saturated in water, drained, and weighed shall hold a minimum of 1,000 grams of water.

[914, line 168]

#####  6. Compost Mulch

 Compost mulch shall consist of well-composted vegetable matter, leaves, yard trimmings, food scraps, composted manures, paper fiber, wood bark, class A bio-solids as defined in Title 40 of the Code of Federal Regulations at 40 CFR Part 503, or any combination thereof. Compost shall be produced using an aerobic composting process in accordance with 40 CFR Part 503 regulations, including time and temperature data indicating effective weed seed pathogen, and insect larvae kill. Compost shall be well decomposed, stable, and weed free. Compost shall be refuse free by less than 1% by weight. Compost shall be free of any contaminants and materials toxic to plant growth. Inert materials shall not exceed 1% by dry weight, pH of 5.5 to 8.0. Carbon-nitrogen ratio shall not exceed 100. Moisture content shall not exceed 45% by dry weight. Variable particle size of the compost shall be a maximum dimension of 3 in. in length, 1/2 in. in width, and 1/2 in. in depth. Compost mulch shall not be used in storm water runoff channels or where concentrated flow is anticipated.

[914, line 276]

####  (f) Balled and Burlapped Plants

 Balled and burlapped plants shall be dug ~~so as~~ to retain as many fibrous roots as possible and shall come from soil which forms a firm ball. The soil in the ball shall be the original and undisturbed soil in which the plant was grown and shall be free of noxious weeds and weed seeds. The plant shall be dug, wrapped, transported, and handled ~~in such a manner that~~*so* the soil in the ball will not be loosened enough to cause stripping of the small and fine feeding roots or cause the soil to drop away from such roots. Any indication of manufactured earth balls or mishandling of the plant will be cause for rejection. The shape and size of the ball shall be as specified in the ASNS as revised herein and shown on the plans.

####  (g) Container Grown Plants

 Plants which are furnished in containers shall be well rooted and established in the container in which they were shipped. An established container grown plant shall be a plant transplanted into a container and grown in that container sufficiently long for the new fibrous roots to have developed so ~~that~~ the root mass retains its shape and holds together when removed from the container.

[914, line 409]

####  (g) Plastic Net

 Plastic net shall consist of photodegradable, longchain synthetic polymer plastic yarn, either extruded oriented or woven into a net with the yarns fixed at each intersection such that they retain their relative positions with respect to each other. The plastic net shall have a square mesh opening of approximately 3/4 in. by 3/4 in. The plastic net shall have a minimum tensile strength of 20 lb over a 3 in. width in the machine direction and 15 lb over a 3 in. width in the transverse direction. The plastic net shall have a nominal mass of 2.8 ±0.4 lb per 1,000 sq ft. The plastic net shall be furnished in rolls which can be easily handled. ~~and t~~*T*he rolls shall be packaged ~~in a suitable protection~~*suitably* for outdoor storage ~~at a construction site, which protects the material from~~*and protection against* degradation prior to use. Roll sizes shall have a minimum width of 6 ft.

## SECTION 915 – BRIDGE PILES AND BEARINGS

[915, line 104]

 (2) Impact Resistance

 The impact resistance of the coating shall be tested in accordance with ASTM G14 using a 0.03 mm minimum coating thickness of a 3.2 mm thick panel at 23°C. Three tests shall be performed. The minimum acceptable value shall be 9.0 N m. of impact with no visible breaks in the coating.

[915, line 128]

######  a. Surface Preparation

 The pile surface shall be blast cleaned in conformance with SSPC-SP-10, Near White Metal Blast. The cleaning media shall produce an anchor pattern profile of 2 mils minimum. All raised slivers, scabs, laminations*,* or bristles of steel remaining on the newly cleaned surface shall be removed by means of abrasive sanders. All traces of grit and dust from the blasting shall be removed.

[915, line 202]

 The soil or rock bearing surfaces of the shoes shall be sloped downward towards the web a minimum of 15° but not to exceed 45° to the horizontal under the flanges. The sloped surfaces of the shoes shall terminate ~~so as~~ to form a flat surface not exceeding 1/3 of the flange width. The surfaces may have individual or continuous cutting teeth.

[915, line 301]

 1. Compressive strain of any layer of an elastomeric bearing shall not exceed 7% at 800 psi average unit pressure or at the design dead load plus live load pressure if ~~so indicated~~*shown* on the plans.

[915, line 334]

 All steel components shall be in accordance with ASTM A709, grade 36 unless otherwise shown on the plans. Where these assemblies are ~~to be~~ used in conjunction with weathering steel, the steel components shall be in accordance with ASTM A709, grade 50W. Stainless steel mating surfaces shall be 14 gauge minimum ASTM A240, type 304 sheets with a maximum surface roughness of 20 Rms.

[915, line 351]

 All steel surfaces exposed to the environment shall be zinc-metalized and shall be 7 mils thick in accordance with SSPC-CS 23.00~~,~~ or painted in accordance with 619.09(a). The finish coat for painted steel shall be in accordance with 909.02(d). The color shall be in accordance with SAE-AMS-STD-595, color No. 20045.

## SECTION 916 – MATERIALS CERTIFICATIONS

[916, line 271]

####  916.04 Sample Asbestos Exclusion Letter

 Prior to acceptance of work and final payment, the Contractor shall submit to the Engineer for each building or bridge, on the Contractor’s letterhead, a signed~~,~~ *and* dated copy of the following letter. The Engineer will be responsible for the distribution of the letter.

## SECTION 917 – QUALITY ASSURANCE AGGREGATE CERTIFICATION

[917, line 4]

 An aggregate source will be authorized to ship products in the status of a Certified Aggregate Producer who is in accordance with the required standards of ITM 211. This will consist of a program which will require the aggregate source to make a commitment to product quality management. Approval to participate in the program will be based on the following criteria~~.~~*:*

 (a) existence of suitable materials in the deposit being mined~~;~~*,*

 (b) facilities capable of consistently processing uniform materials in accordance with the specification requirements~~;~~*,* and

 (c) a source Quality Control Plan which will ensure that the mineral aggregates have a 95% assurance of being in accordance with the Department’s quality and uniformity requirements.

[917, line 24]

###  917.02 Quality Control Plan

 An aggregate source will not be included on the QPL of Certified Aggregate Producers until it has prepared a ~~Quality Control Plan~~*QCP* and the plan has been approved. The plan shall encompass all details of production starting with the extraction of the indigenous raw materials and concluding with material shipped from the plant. The Quality Control Plan shall be prepared in accordance with the requirements of ITM 211.

[917, line 46]

####  (a) Step 1

 The source shall enter the coordinated testing phase of ITM 211. Coordinated testing shall be performed in accordance with ITM 211. During this phase, the producer shall be required to develop a ~~Quality Control Plan~~*QCP* to establish demonstrated mean test values and standard deviations.

####  (b) Step 2

 The aggregate source shall enter the trial phase. The producer shall also operate in accordance with ITM 211 and the ~~Quality Control Plan~~*QCP*. The ~~Quality Control Plan~~*QCP* shall be refined as may be necessary.

[917, line 72]

[.....]A Certified Aggregate Producer shall operate ~~so as~~ to avoid ~~a~~*the* need for the Department to exercise this action. However, removal from Certified Aggregate Producer status may be necessary for situations such as:

 (a) the statistical probability of the product compliance has fallen below 90%~~;~~*,*

 (b) the product has a 90% to 95% probability of compliance*,* but the producer has failed to take corrective action to restore 95% probability~~;~~*,*

 (c) the Certified Aggregate Producer has failed to take immediate corrective action relative to deficiencies in the performance of the approved ~~Quality Control Plan~~*QCP*~~;~~*,*

 (d) evaluation of data has demonstrated an inability of the Certified Aggregate Producer to consistently be in accordance with Department requirements~~;~~*,*

 (e) the Certified Aggregate Producer has deliberately shipped aggregate material which is not in accordance with the specifications, or has falsified records~~;~~*,* or

 (f) the production site has not been operated in accordance with the Summary of Production or Ledge Quality Results letter.

## SECTION 918 – GEOSYNTHETIC MATERIALS

[918, line 14]

###  918.02 Geotextile

 ~~The g~~*G*eotextile shall be either non-woven or woven and consist of at least 85% long-chain synthetic polymers. ~~The g~~*G*eotextile shall contain stabilizers or inhibitors added to the base polymer mix to make the filaments and yarns resistant to deterioration caused by ultraviolet radiation exposure. ~~The g~~*G*eotextile shall be produced such that the yarns and fibers retain their relative positions. The non-woven geotextile shall be needle punched, heat bonded or resin bonded.

[918, line 47]

###  918.03 Geomembrane

 This material shall consist of a geomembrane fabricated from ~~high density polyethylene,~~ HDPE~~,~~ consisting of strong, rot resistant, chemically stable long-chain synthetic polymer materials, dimensionally stable with distinct and measurable openings.

[918, line 73]

###  918.05 Geogrid

 Geogrid shall be abiaxial or multi axial *composition* of a regular network of connected polymer tensile elements with aperture geometry sufficient to enable significant mechanical interlock with the surrounding material. The material shall be polypropylene, ASTM D4101 (97% minimum) and Carbon Black, ASTM D1603 (0.5% minimum). The geogrid structure shall be dimensionally stable and shall be able to retain its geometry under construction stresses. The geogrid structure shall have a resistance to damage during construction, ultraviolet degradation, and all forms of chemical and biological degradation encountered in the soil being placed.

[918, line 112]

$$LTDS =\frac{T\_{ult}}{\left(RF\_{CR}\right)\left(RF\_{IR}\right)\left(RF\_{D}\right)}$$

where:

|  |  |
| --- | --- |
| *LTDS =* | *Long Term Design Strength* |
| Tult = | Ultimate strength |
| RFCR = | Reduction factor for creep |
| RFIR = | Reduction factor for installation damage |
| RFD = | Reduction factor for durability |

## SECTION 919 – TRAFFIC SIGNS

[919, line 111]

 A non-prorated manufacturer’s written warranty~~,~~ against delamination, blistering, discoloration, or 15% or greater loss of retro-reflectivity compared with the minimum initial ASTM D4956 value, shall be provided to, and in favor of, the Department by the reflective sheeting manufacturer. The warranty shall cover a period of 10 years

.

[919, line 137]

#####  2. Non-reflective Sheeting

 Non-reflective sheeting shall be in accordance with ASTM D4956*,* except that the sheeting shall not incorporate optical elements. The color shall be black in accordance with SAE-AMS-STD-595, color No. 17038.

## SECTION 920 – HIGHWAY ILLUMINATION MATERIALS

[920, line 19]

 For conventional light poles, design wind velocity shall be 120 mph. The maximum horizontal deflection of the pole under maximum loading conditions shall not exceed a deflection angle of 1° 40" from the vertical axis of the pole for any 1 ft section of the pole along the entire length of the pole. Poles shall be designed for the Service I, Service II, Extreme I, and Strength I load combination states. The light pole shall be designed to support an ice load of 3 lb/sq ft applied to the full perimeter of all members. Vibration dampers shall be furnished as recommended by the manufacturer. The manufacturer may use drag coefficients based on actual wind tunnel tests~~; otherwise,~~ *or* they shall use the drag coefficients in Table 3.8.7-1. The pole shall also be designed for the Fatigue I load combination state should signs or other appurtenances be specified for mounting on the pole.

[920, line 340]

 The winch shall be driven by a self*-*locking, worm gear reducer. The gear reducer shall be permanently lubricated and totally enclosed in a cast aluminum or cast iron housing. The winch assembly shall be powered by an external drive system.

[920, line 427]

 Each conductor shall be insulated with crosslinked polyethylene manufactured in accordance with Insulated Power Cable Engineer Association standard WC 70/ICEA S-95-658-1999, Nonshielded 0-2kV Cables. ~~Each conductor shall have the following characteristics: a 600 volt rating; UL listed; an XHHW conductor temperature rating not to exceed 90°C in dry locations; and not to exceed 75°C in wet locations~~*Each conductor shall have a 600-volt rating, be UL listed, and have an XHHW conductor temperature rating not to exceed either 90°C in dry conditions and 75°C in wet conditions.*

[920, line 447]

#####  4. Sign and Underpass Wiring

 The wiring from the switch box to the last luminaire shall be 3/C copper stranded No. 10 AWG conductors and shall have imprinted at regular intervals along the length of the insulation jacket the following designation: No. 10 AWG, type MTW or THWN, or Gasoline and Oil Resistant II or AWM, 600 volt, UL. The conductor classifications shall be UL listed and have the following minimum temperature ratings: MTW 90°C~~;~~*,* THWN 75°C~~;~~*,* and AWM 105°C. It shall be installed in 3/4 in. conduit between the breaker box and luminaires.

[920, line 478]

#####  8. Electrical Connectors

 Connectors shall be a compression type of the proper size with only one conductor per groove in the fitting. They shall be designed specifically for use on aluminum and copper conductors, prefilled with an oxide inhibitor*,* and installed with a hydraulic tool according to the manufacturer’s specifications. After installation, the connectors shall be fully insulated and weatherproofed. The connectors installed in underground handhole shall be taped and then waterproofed as shown on the plans.

[920, line 490]

#####  1. General Requirements

 Luminaires shall be compatible with the lighting materials specified ~~in this section~~*herein* and in the plans. Luminaires, including primary fuse protection, surge protection devices, power drivers, and other major components, shall be rated for a minimum operational life of 50,000 hours at 77°F.

[920, line 504]

 Luminaires shall include gasketing that will completely seal out dust, moisture, and insects from the interior of the optical assembly and retard the formation of an undesirable film from gaseous vapors on the interior of the optical assembly. The optical assembly shall be rated at IP 66 or better in accordance with ANSI/IEC 60529*.* ~~while p~~*P*ower drivers, and surge protection devices shall be rated at IP 65 or better.

 Light sources supplied for luminaires shall be electrically compatible with the luminaires. Luminaires shall include an integrally built-in power driver. The luminaire shall operate satisfactorily in temperatures from -40°F to 122°F with an input voltage variation of ±10% of the rated operating voltage specified. Power consumption, wattage, shall not exceed that which is shown on the plans. The luminaire power factor shall be 0.9 or greater. The power driver, or combination of power drivers if more than one is used in the luminaire, shall have a Mean Time To Failure, MTTF, of 1,000,000 hrs as determined by Telcordia SR 332, Issue 3 or MIL-HDBK-217F methodology. The MTTF estimate shall be ~~of~~*for* the driver as a complete and functioning unit. Total Harmonic Distortion, THD, of the power driver shall not exceed 20% as verified by ANSI C82.77.

[920, line 525]

 Refractors or lenses shall be scratch resistant and made from high impact, heat-resistant~~,~~ glass*,* or UV inhibited, high impact polycarbonate plastic. If utilized, reflectors shall be detachable and made of highly specular aluminum.

[920, line 581]

 Metal halide luminaires shall utilize a power driver*s.*~~; e~~*E*xternal capacitors or igniters shall not be used. Metal Halide lamps used in high mast luminaires shall be supported at both ends with mechanical spring grips or other means to hold the lamp secure against vibration.

[920, line 611]

#####  1. Circuit Breakers for Type II Service Point

 The cabinet and hardware shall be weatherproof and rain tight. The enclosure shall have provisions for ~~pad locking~~*padlocking*. The fastener and mounting hardware shall be plated brass, stainless steel, or aluminum. The enclosure shall be made of 14 gauge aluminum*,* or 14 or 16 gauge stainless steel. The circuit breaker operating handles for manual tripping shall be concealed inside the enclosure. Computation of branch circuits shall be based on the National Electrical Code Standard Limitation of loading breakers to 80% of their rated current. Additional details shall be as shown on the plans.

[920, line 636]

#####  4. E-Series Magnetic Circuit Breakers

 These breakers shall have the following features~~.~~*:*

 a. capable of 10,000 on-off operations~~;~~*,*

 b. interrupting capacity of 7,500 amperes~~;~~*,*

 c. temperature stable so as not to be adversely affected by temperature changes over their operating environment of -40°F to 185°F~~;~~*,*

 d. lug range 1/0 - 14 copper and 1/0 - 12 aluminum~~;~~*,* and

 e. trip on overload, even when handle is forcibly held in the ON position.

## SECTION 921 – PAVEMENT MARKING MATERIALS

[921, line 16]

 Heat bonded preformed thermoplastic shall be in accordance with AASHTO M 249*,* ~~with the~~ except~~ion of~~ the application properties outlined in section 5 of AASHTO M 249 shall not apply. Drying time and short term and long term flowability requirements are not applicable at time of installation. The material shall be capable of fusing to itself and previously applied thermoplastic pavement markings when heated. The material shall contain a minimum of 30% beads by weight. The beads shall be homogeneously blended throughout the material. The marking thickness throughout its width, before the material is heated, shall be supplied at a minimum average thickness of 90 mils.

## SECTION 922 – TRAFFIC SIGNAL MATERIALS AND EQUIPMENT

[922, line 26]

 [moved to a separate paragraph] Certification in accordance with 922.02(d) shall also accompany the preliminary product evaluation form. If a product has TS2 communicative capabilities, then a data analysis interpretation offered in a decimal form expressing frames by an SDLC protocol analyzer shall accompany the initial documentation as well. When accuracy of documentation is validated, the evaluation period may commence. In addition, all computer system software applicable to a manufacturer’s product shall work with the Department’s current operating systems so that upgrades will not be needed to recognize the full potential of the product. Any product under evaluation that has an operational failure occurring during the bench test procedure will be rejected and returned to the submitter.

 [moved to a separate paragraph] The product will not be considered for future evaluation without a cover letter documenting failures encountered and changes to the design to correct the failures. A presentation by the manufacturer of the product in question and explanation of why the product failed will be required. Resubmittal of the original product will be expected for testing, evaluation, and approval. Furthermore, two more rejections of a product submitted for evaluation will be cause to deny approval of that model permanently.

 The controller model shall be fully NTCIP 1202 compliant~~,~~ and be capable of logging time-stamped controller event data at 100 ms resolution. The events collected shall be logged in the Department specified data file format and shall include*,* but are not limited to, start and termination of all phase green, amber, and red, pattern changes, and all detector actuations and terminations. Data log file shall be accessible for standard FTP retrieval directly from the controller model’s internal FTP server via the IP addressable RJ-45 Ethernet port.

[922, line 76]

 1. One complete set of wiring and schematic diagrams for ~~all of the~~ CA~~’s~~ panels, racks and wiring. The electronic document shall have a minimum of one indexed page for each paper sheet.

[922, line 93]

 5. Packet number 2 shall also include a paper hard copy and an indexed and searchable electronic format file of the instructional programming manual*,* identical in nature to that approved for use during the evaluation of each product*,* and ~~shall include~~ a TS2 type 2 to TS2 type 1 adapter harness.

 All electronic documents shall be submitted to the Asset Manager in the Department’s Traffic Management Division. Each packet shall be labeled with the name of the intersection, the contract number, the commission number*,* and the date of installation. Packet destinations shall be as per 805.08.

[922, line 110]

####  (c) Warranty

 The ~~manufacturer’s or vendor’s~~ warranty *from the manufacturer or vendor* shall be provided for ~~the following components:~~ all major units operating in a TS2 environment, light emitting diode, LED, signal indications, load switches, and flashers. Warranty periods shall commence from the date of field placement of the device or on the date of signal turn-on as shown on the IC 636A form*,* if purchased through a contracting agent.

####  (d) Certification of NEMA TS2 Traffic Control Equipment

 The following certifications shall be provided.

#####  1. Certification of a Production Run Model

 A certification representing each model of approved major unit of a CA shall be on file with the Department. A certification of a production run model for a CU will be valid for a maximum period of five years from the date of approval or unless a significant change is made in the CU. If a significant change is made, a new certification shall be submitted. A significant change shall be the addition or deletion of any function or feature in the control unit~~,~~ or any other change as defined in 922.02(a) to the circuitry in the product.

#####  2. Certification of Environmental Testing

 A certification shall be provided with each major unit approval request indicating it has been tested and is in accordance with the tests from NEMA TS2-2. The certification shall specify the model and serial number of the product being tested. A complete log of each test shall be provided to the Department and will be maintained by the Department. The log shall ~~show which, if~~*indicate* any~~,~~ controller component ~~failed~~*failure* during the test, when it failed, and what steps were taken to repair the controller. The log shall include the date of testing, name and title of person conducting the tests, a record of conditions throughout the tests, and a temperature and humidity verses time chart. The maximum report interval of any chart shall be 24 h. The chart shall be from a recording machine used to monitor the status of the environmental chamber during testing.

####  (e) NEMA TS2 Fully Actuated Solid State Controller Unit, CU

 The following requirements are the minimum for the design and operation of a 16 channel*,* fully actuated solid state CU. The NEMA TS2 configuration will consist of 2 types of CU’s, type A1 and type A2, as defined in NEMA TS2-3.2.

[922, line 161]

 A removable nonvolatile EEPROM module or removable serial, flash-based, non-volatile data module shall be utilized in each CU to maintain all programmed data. A real-time clock shall be either battery-backed or powered by a super capacitor and active during a power outage ~~so as t~~o provide complete time keeping functions and leap year corrections. A switch or other means shall be provided to turn off or disconnect battery power during storage. This shall be accomplished without physical removal of the battery. Batteries within the CU shall be turned off or disconnected during storage and shipment.

[922, line 179]

#####  2. CU Requirements

 The requirements set forth herein refer to a type A1 and A2 CU. ~~Where d~~*D*ifferences ~~occur~~ between types~~, it~~ will be designated.

 The CU shall have, as a minimum, the internal diagnostics defined by NEMA TS2-3.9.3.

 The CU shall monitor and log the status of events as specified in NEMA TS2-3.9.3.1.5 in non-volatile memory and shall be selectable via program entry and be retrievable by the system computer via NEMA port 2 or 3. In addition, the CU shall have the ability to log an MMU fault as it occurs. A minimum of 16 entries shall be stored in non-volatile memory. When capacity is exceeded, the oldest entry will be replaced by the newest. Logged entries shall*,* at *a* minimum*,* contain the date and time denoted in military style with minute resolution, description of the fault as it would appear on the MMU, and the status of each of the channel inputs at the time the fault occurred, clearly denoting the presence of activity on a channel.

[922, line 222]

#####  4. CU Enclosure

 The enclosure shall be of adequate strength to protect the components during normal handling. The keypad, liquid crystal display*,* and all interface connectors required for the operation and standard field adjustments shall be mounted on the front panel. Fusing shall be on the front panel of the CU and shall provide protection from internal or external overload.

[922, line 240]

####  (f) NEMA TS2 Cabinet, Auxiliary Equipment, and Terminal and Facilities, TF, Requirements

 These standards define the minimum requirements for a TS2 type A1 cabinet, both inside and out. The performance and construction of the cabinet shall be in accordance with the applicable requirements of NEMA TS2 sections 4, 5, 6, and 7. The serial number and model number of the auxiliary equipment shall be permanently applied externally on or near the front of the product. Programming and maintenance manuals for approved products shall be identical in nature to that approved for use during the evaluation period of the product. The Department shall be notified of all changes to the documentation. Manufacturer specific enhancements are acceptable*.*~~, however n~~*N*o function or device shall preclude the interchangeability of an auxiliary product with another product of like NEMA specification within a controller assembly.

[922, line 263]

 The main cabinet door shall use a Corbin lock No. 2 and each cabinet shall be furnished with two No. 2 keys. The lock shall open in a counterclockwise motion only. The door shall be capable of being opened and stopped in*,* at least*,* ~~the following~~ two ranges of degree opening*s* as measured from the face of the cabinet door on the hinged side: 80 to 100°, and 170 to 190°. The door shall be hinged on the right side of the cabinet. The main door and the police panel door shall close against a weatherproof and dustproof gasket seal, which shall be permanently bonded to the cabinet. A standard police panel key shall be provided with each cabinet.

[922, line 310]

######  c. Receptacle

 The cabinet shall contain one duplex convenience outlet and a lamp receptacle that is actuated and turns on when the door is open and goes off ~~upon closing of~~*when* the door *is closed.*~~and an internal On/Off switch which can override the preceding~~*The cabinet shall also contain an internal On/Off switch to override the lamp receptacle*. The convenience outlet shall be duplex, three-prong, NEMA type 5-15R grounding outlet in accordance with NEMA WD - 6, with ground-fault circuit interruption as defined by the ~~National Electric Code~~*NEC*. These units shall be protected with a 15-ampere cartridge fuse wired ahead of the multi breakers. An additional outlet shall be provided in each cabinet and shall be a duplex, three-prong, NEMA type 5-15R grounding outlet wired after the cabinet surge protection. This unit shall be protected with a 10-ampere cartridge fuse. The additional outlet in master cabinets shall be powered by the 10-ampere circuit breaker and through a separate power interrupt switch providing separate control of the master CU power supply.

[922, line 361]

######  a. General Requirements

 The TF layout shall be in accordance with NEMA TS2-5.2.7. The cabinet shall contain a main TF panel complying with NEMA TS2-5 standards. The model number of the main panel shall be permanently applied to the front of the panel~~, where it is~~*and shall be* easily readable~~,~~ without removing or disconnecting the panel. Each controller input and output circuit shall terminate on the main TF panel or on a supplementary panel. The phase arrangement of the controller shall coincide with the channel arrangement of the load switches and MMU. All outputs on channels 9 through 12 field connections shall have a 1μF capacitor placed at each output terminal on the front of the TF panel. All TFs within the cabinet shall be readily accessible for field connection without removing the controller or associated equipment and for maintenance in the cabinet. All stranded wiring shall be tinned. A 24 volt relay shall be used on the TF to remove 24V DC from the common side of the load switches, effectively taking the mercury relay out of the circuit when the signal is put in mechanical flash. The TF panel shall be hinged at the bottom and capable of swinging down to allow accessibility of the wiring and terminals at the rear of the panel. The backpanel shall be attached to the cabinet such that access to the backside of the backpanel, for maintenance purposes, shall be accomplished without the use of special tools or removal of auxiliary panels, shelving, or other cabinet appurtenances. A bracket extending at least half the length of the NEMA load switch shall support all load switches.

[922, line 423]

 The cabinet shall contain a 50kA, 8x20μs surge suppressor. The surge suppressor shall be a 120V AC, 15A, minimum 2-stage parallel/series type device and protect lines: line-neutral, line-ground and neutral-ground, have a maximum continuous operating voltage of 140V AC, maximum clamp voltage of 350 volts*,* and device status indicators of green/good and red/failed. The device shall plug into a NEMA 12 position terminal base wired before and in parallel with the 35 or 40A main signal buss circuit breaker and in series with the 10A circuit breaker for the solid state equipment and provide for a tool-free replacement of the device. There shall be a minimum of two electrical receptacles on the equipment side of the device for future auxiliary equipment. The surge suppressor shall operate between -30 to 165°F. The dimensions of the unit shall not exceed 4 1/2 in. wide by 7 in. long by 3 1/2 in. deep.

[922, line 503]

######  c. Detector Rack

 Each detector rack shall be labeled at the bottom of the rack with a continuous label. The label shall be 1 in. wide, thermal printed black on clear, white*,* or matte polyester tape with permanent adhesive, water, chemical and scratch resistant printed with 4 lines of Arial, size 10 font. Below the BIU shall be the BIU number and detector channel numbers that are contained within the rack as follows: (1-16), (17-32), (33-48), (49-64). This area shall also contain the intersection for diamond interchanges controlled from one cabinet. Each slot shall be labeled below the module with the corresponding loop tag information~~;~~*.* ~~t~~*T*he count output number portion of the information shall be under the first part of the tag information. For each two-channel module, ~~channel 2’s~~*the* label *for channel 2* shall be below *the label for* channel 1~~’s label.~~

[922, line 621]

 Minimum dimensions for the cabinet shall be 12 in. deep, 12 in. wide*,* and 12 in. high. The maximum dimensions shall be 18 in. deep, 15 in. wide*,* and 18 in. high.

[922, line 683]

#####  2. Incandescent Signal Indications

 All new traffic signal and flasher installations that include new indications shall be fitted with LED’s. The minimum design requirements for replacement incandescent light bulbs ~~to be~~ used in a traffic signal face shall be in accordance with the Institute of Transportation Engineers standard for traffic signal bulbs.

[922, line 798]

 Each pedestrian signal shall be completely wired internally~~,~~ and ready for connection of the field wiring. A suitable terminal block for connection of the internal wiring and the incoming field wires to the pedestrian signal head shall be provided in the signal housing.

[922, line 842]

#####  5. Accessible Pedestrian Push Buttons

 When ~~accessible pedestrian signals,~~ *an* APS~~,~~ ~~are~~*is* specified, the push-button shall have audible and tactile features. The push-button shall activate both the Walk interval and the APS. The color of the actuator shall contrast visually with the housing or mounting. A standard manufacturer’s warranty shall be provided.

[922, line 889]

 The disconnect hanger shall be designed so ~~that~~ the maximum allowable space or play between the span hanger and the eye-bolt of the balance adjuster and between the balance adjuster and the disconnect hanger clevis, at points where they are attached to each other by rivet pins or hex head bolts and nuts with lock washers, shall be 0.062 in. The span hanger bolt where the eye-bolt or the balance adjuster is attached shall be 5/8 in. diameter.

[922, line 929]

####  (a) Clearance

 The maximum allowable space or play between the hanger assembly and the eye-bolt of the balance adjuster and between the balance adjuster and the weatherhead clevis, at points where they are attached to each other by rivet pins or hex head bolts and nuts with lock washers, shall be 0.062 in. No bushings or shims will be allowed in this assembly.

[922, line 956]

####  (d) Tether Bracket

 The tether bracket shall attach to a 1/4 in. tether and prevent the bottom of the head from moving side-to-side on the tether. Where backplates are installed on the signal heads, the tether bracket shall be of the proper length for the backplate so that the cable is mounted below the bottom of the backplate to avoid interference with head alignment and damage to the backplate. Three bolts, nuts, and washers~~,~~ shall be used to secure the tether bracket to a three-section or four-section signal head. A wire rope clamp in accordance with 922.10(e)4c~~,~~ shall be used to secure the tether bracket to the tether. The tether bracket shall have predrilled 1/2 in. diameter holes. In lieu of the wire rope clamp and 1/2 in. diameter holes, a beveled tether plate that completely fills in the extruded portion of the tether bracket may be used to secure the tether bracket to the tether. The tether bracket shall not extend more than 2 in. below the tether.

[922, line 980]

###  922.08 Signal Cantilever Mount Signal Bracket

 The bracket shall allow the following four adjustments:

 (a) rotational adjustment about bracket axis~~;~~*,*

 (b) vertical adjustment~~;~~*,*

 (c) rotational adjustment about signal cantilever arm~~;~~*,* and

 (d) rotational adjustment right and left from vertical plane

[922, line 1035]

 The base shall be attached to a foundation by four anchor bolts, with an anchor bolt circle of 12 3/4 in. Slotted lugs shall be integrally cast into the four corners of the base for attachment of the anchor bolts. The anchor bolts shall be steel in accordance ~~to~~*with* ASTM F1554, Grade 36. The diameter of the anchor bolt shall be 3/4 in. with a minimum length of 18 in. ±1/2 in., plus 2 1/2 to 3 in. right angle hook on the unthreaded end. The top 4 in. of the bolt shall be threaded with 10 NC threads. The threads, plus 3 in., shall be hot-dip galvanized in accordance with ASTM F2329 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM B695, Class 55. Each anchor bolt shall be provided with two high strength heavy hex head nuts in accordance with ASTM A563 and three washers. Two of the washers shall have a minimum 2 in. and maximum 2 1/8 in. outside diameter and be in accordance ~~to~~*with* ANSI B 27, type B regular series and one shall be a nominal 3/4 in. series W washer, in accordance with ASTM F436.

 The cast aluminum pedestal base shall be in accordance with the dimensions and requirements shown on the plans. The casting shall be true to pattern in form and dimensions~~;~~*,* free from pouring faults, sponginess, cracks, ~~and~~ blowholes~~;~~*,* and free from other defects in positions affecting the strength and value of the intended use for the casting. The base shall not have sharp unfilleted angles or corners. The surface shall have a workmanlike finish.

[922, line 1109]

 All hardware, handhole cover and latching device, and band-type steel polebands shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM B695, Class 55. All nuts and bolts, except anchor bolts, shall be in accordance with ASTM A307, and shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. If a cast pole top or cap is used*,* it shall be in accordance with ASTM A126 and shall be galvanized with a minimum coating of 2 oz/sq ft.

[922, line 1184]

 The signal cantilever arm and combination arm, if required, shall be attached to the pole as shown on the plans. The arms shall have cable inlets as shown on the plans. All signal heads on the arm shall be attached as shown on the plans, ~~and~~ installed parallel to the horizontal plane*,* and centered to the cantilever arm. The cantilever arms shall be used as an enclosed raceway for wiring and shall be free of burs or rough edges.

[922, line 1194]

#####  2. Base Plate

 A one-piece anchor base *plate* shall be supplied as shown on the plans. Four removable bolt covers shall be provided with each base and each cover shall attach to the upright portion of the body of the base by means of one-hex head cap screw.

[922, line 1218]

#####  5. Anchor Bolts

 Four steel anchor bolts, each fitted with two high strength heavy hex nuts and two flat washers, shall be furnished with each pole. The anchor bolt shall be as shown on the plans with a minimum of 15 in. of ~~seven~~*7* NC threads on the upper end. The threads, nuts, and washers shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. The steel for the bolt shall be in accordance with ASTM F1554, with a yield strength of 36,000 or 55,000 psi.

[922, line 1235]

####  (d) Downguys, Anchors, Rods, and Guards

 Pole anchors shall be ~~eight~~*8-* way expanding with a minimum area of 135 sq in. when expanded or a 10 in. diameter screw anchor. They shall have a minimum holding strength of 10,000 lb. They shall be painted and in accordance with ASTM A575. Anchor rods for expanded anchors shall be 3/4 in. diameter steel and for screw anchors shall be 1 1/4 in. diameter steel, 8 ft long, in accordance with ASTM A659, and be galvanized in accordance with ASTM A153.

[922, line 1259]

#####  2. Span, Catenary, and Downguy Cable

 Span, catenary, and downguy cable, shall be aircraft cable for non-aircraft use, ~~and shall~~ be 3/8 in. nominal diameter, made of stainless steel wire, and consist of seven~~,~~ 19-wire flexible steel strands. The 3/8 in. cable shall have a minimum breaking strength of 12,000 lb. It shall be in accordance with Military Specifications MIL-W-83420D.

[922, line 1350]

 Each individual fiber shall be 2.5/5 mils (62.5/125 µm) diameter, core/color-coded clad, and each color-coded set of fibers shall be encased in a loose tube buffer with water blocking tape on the outside and fully water blocked inside using craft-friendly, water-swellable yarns. The fiber optic cable shall be constructed with Kevlar braid and outer polyethylene jackets as a minimum. If an inner jacket is used*,* it shall be PVC. Maximum attenuation of the cable shall be 4.0 dB/km nominal, measured at room temperature at 850 nm. The bandwidth shall not be less than 160 MHz/km, also at 850 nm. Each fiber shall be continuous with no factory splices except for joining standard length cables to form longer, continuous jacketed cable to fit installation requirements. The cable shall have standard nylon rip cords. Kevlar rip cords will not be accepted.

[922, line 1483]

 The various conduit fittings such as bands, bodies, straps, lock nuts, and threadless connectors, shall be in accordance with Federal Specifications A-A-50553*,* and shall be galvanized if not stainless steel. Conduit straps shall be two hole straps with a minimum thickness of 1/8 in. Conduit lock nuts 3/8 to 1 1/2 in. in size shall be made of steel. Other sizes shall be made of either steel or malleable iron. All conduit lock nuts shall be galvanized. Other nuts shall be either stainless steel or galvanized steel.

[922, line 1495]

####  (c) Fiberglass Conduit

 Rigid fiberglass conduit and fittings shall be filament wound consisting of E-glass and corrosion resistant epoxy resin manufactured for use at temperatures from -40 to 230°F. Rigid fiberglass conduit shall be pigmented with carbon black for ultraviolet protection and fire resistant per UL 94. All rigid fiberglass conduit shall have tracer wire, be heavy walled, HW, and meet the specifications, labeling*,* and testing of ANSI/NEMA TC9.

## SECTION 923 – TEMPORARY TRAFFIC CONTROL DEVICES

[923, line 3]

###  923.01 Temporary Pavement Marking Tape

 Temporary pavement marking tape shall be furnished in three colors and two types. It shall consist of a white or yellow film that provides both dry and wet retro-reflectivity on a conformable backing ~~which is a minimum~~ of 4 in. ~~wide,~~*minimum width* and ~~is~~ designed for marking either asphalt or concrete pavements. Black temporary pavement marking tape shall consist of a matte film on a conformable backing which is designed for marking asphalt pavement. White and yellow temporary pavement marking tape shall be in accordance with ASTM D4592.

[923, line 74]

#####  3. Reflex-Reflective Performance

 For types A and C*,* the specific intensity of the lens when acting as a reflex‑reflector at an observation angle of 0.2 of a degree shall be no less than the following~~.~~*:*

[923, line 166]

 The lamps shall be electronically operated by means of a solid state controller. An automatic lamp intensity regulator shall hold the lamp output constant with varying battery voltage. The control system shall incorporate a full-time tracking system designed to track ambient light for 24 h a day. The control system shall adjust lamp intensity to provide maximum system efficiency. The controller shall be in a weatherproof, ventilated, lockable enclosure.

[923, line 177]

 The battery bank shall consist of 12V, deep cycle~~,~~ batteries. The battery bank shall be of sufficient capacity to power the unit for 15 days with no assistance from the sun. A battery condition indicator and a test switch shall be provided to monitor the ~~system’s~~ battery charge *of the system*. The batteries shall be secured in a well ventilated, weatherproof lockable housing. A low battery charge indicator which shall be visible to maintenance personnel driving past the sign shall be provided to indicate the need to recharge the batteries. The battery bank shall be at full charge when delivered to the project site.

[923, line 203]

###  923.05 Portable Changeable Message Sign

 Portable changeable message signs shall be capable of displaying 3 lines with ~~of~~ 8 characters per line. Letter height shall be a minimum of 18 in. The sign shall have automatic dimming capability for nighttime operation.

## SECTION 925 – ITS CONTROLLER CABINET

[925, line 74]

 The door~~’s hinging~~*hinges* shall be three or four bolt butt hinges. Each hinge shall have a fixed pin. Doors larger than 22 in. in width or 6 sq ft in area shall be provided with catches to hold the door open at both 90° and 180°, ±10°. The catches shall be 1/3 in. diameter, minimum, plated steel rods. The catches shall be capable of holding the door open at 90° in a 56 mi/h wind at an angle perpendicular to the plane of the door. Door hinges, pins, and bolts shall be made of stainless steel. The hinges shall be bolted to the cabinet. The hinge pins and bolts shall not be accessible when the door is closed.

[925, line 86]

 Both cabinet doors shall have louvered openings and shall provide ventilation. A filter shall be provided over the louvers and shall include an aluminum filter cover secured with a spring-loaded latch as shown on the plans. The filter shall be 12 by 16 by 1 in. Two spare filters shall be provided with each cabinet.

[925, line 108]

 Only models from the QPL of Traffic Signal and ITS Devices in effect as of the date of letting, or as otherwise specified, shall be used on the contract. Continued failure and repeated malfunctions of a qualified controller or control equipment shall be ~~a~~ cause to remove that model from the QPL. A design change to a qualified model or cabinet will require re-submittal of the model for testing, evaluation, and approval. Permanent addition or removal of component parts or wires will be considered ~~to be~~ a design change.

[925, line 133]

The equipment rack shall be furnished with two adjustable equipment shelves. A 3 in. hole shall be provided in each shelf. The hole shall be fitted with a nylon snap bushing liner with an outside diameter of 3.16 in., inside diameter of ~~2 1/2~~*2.5*in. and a height of 0.72 in. The shelves shall be constructed of an aluminum screen tack welded between the shelf bottom and upper ribs. The shelves shall be capable of being moved in any location.

[925, line 227]

####  (o) Terminal Strip Surge Protector

One 48 in. surge protected terminal strip with ten 15~~A~~*amp* outlets shall be furnished and installed.

[925, line 342]

 All wire shall be type THHN with color and gauge as shown on the plans*,* ~~with the exception of~~*except* the microloop card rack wiring which will be two-pair twisted with a shield and plenum rated.

[END OF EDITS]