Florida Department of Transportation

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STEPHANIE KOPELOUSOS
SECRETARY

January 15, 2009

Monica Gourdine
Program Operations Engineer
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: Office of Design, Specifications
Section 462
Proposed Specification: 4620400 Post Tensioning - Materials

Dear Ms. Gourdine:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

This change was proposed by Charles Boyd to reference Section 413 for Methacrylate and to delete the field conducted wick induced bleed test.

If you have any questions relating to this specification change, please call Rudy Powell, State Specifications Engineer at 414-4110.

Sincerely,

Signature on File

Rudy Powell, Jr., P.E.
State Specifications Engineer

RP/ft
Attachment
cc: Gregory Jones, Chief Civil Litigation
Florida Transportation Builders' Assoc.
State Construction Engineer

**POST-TENSIONING - MATERIALS.**

**(REV ~~10-31-07~~*1-14-09*) ~~(FA 2-14-08) (7-08)~~**

ARTICLE 462-4 (of the Supplemental Specifications) is deleted and the following substituted:

**462-4 Materials.**

Meet the requirements of following:

| | |
|---|---|
| Wire Strand* | ASTM A 416 |
| Bar** | ASTM A 722 |
| Water | Section 923 |
| Grout | Section 938 |
| Epoxy Grout | Section 926 |
| Magnesium Ammonium Phosphate Concrete | Section 930 |
| Elastomeric Coating System | Section 975 |
| *Methacrylate* | *Section 413* |

**462-4.1 Prestressing Steel:**

(a) Strand: Unless otherwise noted on the plans, use uncoated strand meeting requirements of Section 933 (Grade 270, low relaxation 7-wire strand meeting the requirements of ASTM A 416).

(b) Bar: Unless otherwise noted on the plans, uncoated Grade 150, high strength, coarse thread bar meeting the requirements of ASTM A 722, Type II.

**462-4.2 Post-Tensioning System:** Use approved post-tensioning systems, of the proper size and type to construct tendons shown on the Contract Documents. Substitution of components of approved post-tensioning systems is not permitted. For permanent applications, the use and location of bar couplers is subject to approval by the Engineer. Use only post-tensioning systems that utilize tendons fully encapsulated in anchorages and ducts. Systems which transfer prestress force by bonding the prestress steel strand directly to concrete are not permitted. Embedded anchors for bars are permitted. Systems utilizing formed, ungrouted voids or “Diablos” are not permitted. Strand or tendon couplers are not permitted.

**462-4.2.1 Post-Tensioning Anchorages:** Ensure that the anchorages develop at least 95% of the actual ultimate tensile strength of the prestressing steel, when tested in an unbonded state, without exceeding the anticipated set.

Design anchorages so that the average concrete bearing stress is in compliance with the “AASHTO LRFD Bridge Design Specifications”. Test and provide written certification that anchorages meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications.

Galvanize the embedded body of the anchorage in accordance with ASTM 123. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. Construct the bearing surface and wedge plate from ferrous metal. Equip all anchorages with a permanent grout cap that is vented and bolted to the anchorage.

Provide wedge plates with centering lugs or shoulders to facilitate alignment with the bearing plate.

Cast anchorages with grout outlets suitable for inspection from either the top or front of the anchorage. The grout outlet will serve a dual function of grout outlet and post-grouting inspection access. The geometry of the grout outlets must facilitate being drilled using a 3/8" diameter straight bit to facilitate endoscope inspection directly behind the anchor plate. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type each providing singular inspection entry locations.

Trumpets associated with anchorages will be made of either ferrous metal or polypropylene plastic material conforming ~~with~~*to* the requirements stated in 462-4.2.5.5. The thickness of the trumpet at the transition location (choke point) will not be less than the thickness of the duct as established in 462-4.2.5.5. Alternately, the trumpet material may be polyolefin containing antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of not less than 20 minutes. Perform OIT test on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F 2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours.

**462-4.2.2 Bar Couplers:** Use couplers meeting the requirements of AASHTO LRFD Bridge Design Specifications and Bridge Construction Specifications. Test and provide written certification that the couplers meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications.

**462-4.2.3 Inlets, Outlets, Valves and Plugs:** Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A 240 Type 316 stainless steel, nylon or polyolefin materials. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Products made from polyolefin shall contain antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of not less than 20 minutes. Perform OIT test on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F 2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours. All inlets and outlets will be equipped with pressure rated mechanical shut-off valves or plugs. Inlets, outlets, valves and plugs will be rated for a minimum pressure rating of 150 psi. Use inlets and outlets with a minimum inside diameter of 3/4 inch for strand and 3/8 inch for single bar tendons and four-strand duct.

Provide dual mechanical shutoff valves when performing vertical grouting. Specifically designate temporary items, not part of the permanent structure, on the PT System drawings. Temporary items may be made of any suitable material.

**462-4.2.4 Permanent Grout Caps:** Use permanent grout caps made from approved polymer or ASTM A 240 Type 316L stainless steel. The approved resins used in the polymer shall be ~~either nylon~~*nylon*, Acrylonitrile Butadiene Styrene (ABS) or polyester. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Seal the cap with "O" ring seals or precision fitted flat gaskets placed against the bearing plate. Place a grout vent on the top of the cap. Grout caps must be rated for a minimum pressure rating of 150 psi. Use ASTM A 240 Type 316L stainless steel bolts to attach the cap to the anchorage. When

stainless steel grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel.

**462-4.2.5 Duct and Pipe:**

**462-4.2.5.1 General:** Use only plastic duct, steel pipe or a combination of plastic duct and steel pipe. Ensure that all connectors, connections and components of post-tensioning system hardware are air and water tight and pass the pressure test requirements herein. Use smooth plastic duct in all post-tensioning systems used for external tendons. Use corrugated plastic duct in all post-tensioning systems used for all internal tendons except where steel pipe is required.

**462-4.2.5.2 Duct or Pipe Minimum Diameter:** For prestressing bars, provide duct with a minimum internal diameter of at least 1/2 inch larger than the outside diameter, measured across the deformations. For prestressing bars with couplers, size the duct to be 1/2 inch larger than the diameter of the bar and/or coupler.

For multi-strand tendons, provide ducts with a minimum cross-sectional area 2 1/2 times the cross-sectional area of the prestressing steel.

**462-4.2.5.3 Connection Tolerance ~~Between~~ *between* Pipe and Duct:** Steel pipe and plastic duct may be connected directly to each other when the outside diameters do not vary more than ± 0.08 inch. Use a reducer when the diameters of the steel pipe and the plastic duct are outside of this tolerance.

**462-4.2.5.4 Steel Pipes:** Use galvanized schedule 40 steel pipes where shown in the plans and in all deviation blocks and diaphragms.

**462-4.2.5.5 Corrugated Plastic Duct:** Do not use ducts manufactured from recycled material. Use seamless fabrication methods to manufacture ducts.

Use corrugated duct manufactured from non-colored, unfilled polypropylene meeting the requirements of ASTM D4101 “Standard Specification for Polypropylene Plastic Injection and Extrusion Materials” with a cell classification range of PP0340B14541 to PP0340B67884. The duct shall be white in color containing antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of 20 minutes and containing a non-yellowing light stabilizer. Perform OIT test on samples from the finished product. Furnish duct with a minimum thickness as defined in the following table:

| Duct Shape | Duct Diameter | Duct Thickness |
|---|---|---|
| Flat | any size | 0.08 inch |
| Round | 0.9 inch | 0.08 inch |
| Round | 2.375 inches | 0.08 inch |
| Round | 3.0 inches | 0.10 inch |
| Round | 3.35 inches | 0.10 inch |
| Round | 4.0 inches | 0.12 inch |
| Round | 4.5 inches | 0.14 inch |

| Duct Shape | Duct Diameter | Duct Thickness |
|---|---|---|
| Round | 5.125 inches | 0.16 inch |
| Round | 5.71 inches | 0.16 inch |

**462-4.2.5.5.1 Testing Requirements for Corrugated Plastic Duct:** Ensure that the duct system components and accessories meet the requirements of Chapter 4, Articles 4.1 through 4.1.8 of International Federation of Structural Concrete (FIB) Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning” as modified herein.

The requirements in FIB Technical Report, Bulletin 7, are modified as follows: Conduct the lateral load resistance test (FIB 4.1.4), without the use of a duct stiffener plate, using a load of 150 lbs. for all sizes; Wear resistance of duct (FIB 4.1.7) must not be less than 0.06 inch for duct up to 3.35 inches in diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter; Bond length test (FIB 4.1.8) must achieve 40 % GUTS in a maximum length of 16 duct diameters.

**462-4.2.5.5.2 Minimum Bending Radius for Corrugated Plastic Duct:** In addition to the component testing stated herein, the manufacturer shall establish, through testing, the minimum bending radius for the duct. The test consist of a modified duct wear test as described in Chapter 4, Article 4.1.7 of FIB Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning”. The test apparatus shall be identical to the wear test apparatus with the same clamping force as a function of the number of strands in the duct; however, modify the procedure as follows: do not move the sample along the strand to simulate wear; the test duration will be 7 days. Upon completion of the test duration, remove the duct and the minimum wall thickness along the strand path must not be less than 0.06 inch for duct up to 3.35 inches diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter.

**462-4.2.5.5.3 Corrugated Duct Connections and Fittings:** Make all splices, joints, joints between segments (segmental construction), couplings and connections to anchorages with devices or methods (i.e. mechanical couplers, plastic sleeves in conjunction with shrink sleeve) producing a smooth interior alignment with no lips or kinks. Design all connections and fittings to be airtight. Duct tape is not permitted to join or repair duct connections.

Construct connections and fittings from polyolefin materials containing antioxidant stabilizer(s) meeting the requirements established in 462-4.2.3 or 462-4.2.5.5.

For post-tensioned systems intended for use with segmental constructed box girder bridges, the post-tensioning system shall include duct couplers at the segment joints. The tendon duct coupler located at the segment joint shall be mounted perpendicular to the bulkhead and designed to receive a duct at an angle of 6 degrees deviation from perpendicular. The coupler must be able to accommodate angular deviation of the duct without the tendon strands touching the duct or coupler on either side of the segment joint.

**462-4.2.5.6 Smooth Duct:** Use smooth duct manufactured from 100% virgin polyethylene resin meeting the requirements of ASTM D 3350 with a minimum cell class of 344464C. Use resin containing antioxidant(s). Perform OIT test on

samples taken from the finished product resulting in a minimum Oxidative Induction Time (OIT) according to ASTM D 3895 of 40 minutes. Manufacture duct with a dimension ratio (DR) of 17.0 or less as established by either ASTM D 3055 or ASTM F 714 as appropriate for the manufacturing process used.

Use smooth duct meeting the minimum pressure rating (working pressure) of 100 psi and manufactured to either of the following Specifications: ASTM D 3035 “Standard Specifications for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter” or ASTM F 714 “Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter”.

**462-4.2.5.6.1 External Smooth Duct Connections:** Use heat welding techniques to make splices between sections of plastic duct, in accordance with the duct manufacturers’ instructions or make connections with electrofusion coupler or other mechanical couplers meeting the material requirements of this Specification. Ensure all connections have a minimum pressure rating (working pressure) of 100 psi, produce a smooth interior alignment and a connection with no lips or kinks.

Ensure all connections between steel pipe embedded in concrete and plastic duct are made by using a mechanical coupler or a circular sleeve made of Ethylene Propylene Deine Monomer (EPDM), having a minimum pressure rating (working pressure) of 100 psi. Use EPDM materials having 100 % quality retention as defined by ASTM D 1171 Ozone Chamber Exposure Method B.

Use EPDM sleeves having a minimum wall thickness of 3/8 inch and be reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide power seated band and clamps constructed from 316 stainless steel on each end of the boot to seal against leakage of grout. Install the band with an 80 to 120 lb seating force.

**462-4.2.5.7 Corrugated Ferrous Metal Ducts:** Do not use corrugated ferrous metal ducts in any location.

**462-4.2.5.8 Shipping and Storage of Ducts:** Furnish duct with end caps to seal the duct interior from contamination. Ship in bundles which are capped and covered during shipping and storage. Protect ducts against ultraviolet degradation, crushing, excessive bending, dirt contamination and corrosive elements during transportation, storage and handling. Do not remove end caps supplied with the duct until the duct is incorporated into the bridge component. Store duct in a location that is dry and protected from the sun. Storage must be on a raised platform and completely covered to prevent contamination. If necessary, wash duct before use to remove any contamination.

**462-4.2.6 Internal Duct Mechanical Couplers, O-Rings, Segment Seal Assemblies and Heat Shrink Sleeve Requirements:** Ducts for prestressing bars used exclusively for temporary post-tensioning are not required to be coupled across segment joints.

**462-4.2.6.1 Mechanical Couplers:** Construct mechanical internal duct couplers with stainless steel, plastic or a combination of these materials. Use plastic resins meeting the requirements for of sections 462-4.2.3 or 462-4.2.5.5 to construct plastic couplers. Use ASTM A 240 Type 316 stainless steel to make metallic components.

**462-4.2.6.2 O-rings:** Provide O-ring duct coupling assemblies and **s**egment seal mounting assemblies made from plastic resins meeting the requirements of sections 462-4.2.3 or 462-4.2.5.5.

Furnish standard O-ring material (diameter $\leq$ 0.25 inch) conforming with the following requirements:

**Mechanical Properties**

Shore hardness, A ASTM D2240 ..... 50-75
Ultimate elongation %, ASTM D412 .....250 % Min.
Tensile strength, ASTM D412..... 1400 psi Min.

**Accelerated Testing**

Thermal Deterioration 70 hours @ 257$^{o}$ F, ASTM D573
Change in tensile strength.....± 30 %
Change of elongation.....-50 %
Change of hardness.....± 15 points
Compression Set Method B 22 hours @257$^{o}$ F, ASTM D395..... 50 %
Volume change due to absorption of $H_2O$, Method D, for 70 hours @ 212$^{o}$ F, ASTM D471.....+ 10 %

**Environmental Resistance**

Ozone Resistance Exposure Method B, ASTM D1171..... Pass
Low Temp. Non-brittle after 3 Min. @ -40$^{o}$F, ASTM D2137..... Pass

Furnish segment seal assemblies for large diameter compression seals, used to couple ducts at segment joints, which conform with the requirements stated above and with the following additions and changes:

**Mechanical Properties**

Shore hardness, A ASTM D2240 ..... 30-40
Tensile strength, ASTM D412..... 600 psi Min.
Compression Set Method B 22 hours @257$^{o}$ F, ASTM D395..... 60 %

**Compression Force -** The maximum force to compress the O-ring to its final compressed position shall not be greater than 25 psi times the area encircled by the O-ring.

**Voided Area -** The seal shall be designed to accommodate the material flow within its own cross sectional area by using a hollow or voided design.

**Mounting Assemblies -** Assemblies holding the O-ring must mount to the form bulkhead and provide for duct alignment.

**462-4.2.6.3 Heat Shrink Sleeves:** Furnish heat shrink sleeves having unidirectional circumferential recovery manufactured specifically for the size of the duct being coupled consisting of an irradiated and cross linked high density polyethylene backing for external applications and linear-density polyethylene for internal applications. Furnish adhesive having the same bond value to steel and polyolefin plastic materials. Ensure the heat shrink sleeves have an adhesive layer that will withstand 150° F operating temperature and meet the requirements of the following table:

| Property | Test Method | Minimum Requirements | |
|---|---|---|---|
| | | Internal Application | External Application |
| Minimum Fully Recovered Thickness | | 92 mils | 111 mils |
| Peel Strength | ASTM D 1000 | 29 pli | 46 pli |
| Softening Point | ASTM E 28 | 162°F | 216°F |
| Lap Shear | DIN 30 672M | 87 psi | 58 psi |
| Tensile Strength | ASTM D 638 | 2,900 psi | 3,480 psi |
| Hardness | ASTM D 2240 | 46 Shore D | 52 Shore D |
| Water Absorption | ASTM D 570 | Less than 0.05% | Less than 0.05% |
| Color | | Yellow | Black |
| Minimum Recovery | Heat Recovery Test | 33% | 23% |

Install heat shrink sleeves using procedures and methods in accordance with the manufacturer's recommendations.

**462-4.2.7 System Test Requirements:** For each family of post-tensioning systems, assemble systems and perform the pressure test defined herein. For each family of post-tensioning systems test two assemblies (largest and smallest) from the family. The post-tensioning assembly includes at least one of each component required to make a tendon from grout cap to grout cap. If applicable, include plastic duct to steel pipe connections and segment duct couplers.

**462-4.2.7.1 Grouting Component Assembly Pressure Test:** Assemble anchorage and grout cap with all required grouting attachments (grout tube, valves, plugs, etc.). Seal the opening in the anchorage where the duct connects. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five minutes with no more than 15 psi reduction in pressure. For systems using the same anchorages, grout caps and grouting attachments as a previously approved system, the Grouting Component Assembly Pressure Test may include documentation from a previous submittal with written certification that the same components are being utilized in both anchorages.

**462-4.2.7.2 External Duct Systems:** System testing for external duct requires two additional tests. (1) The anchorage and its connection to the duct/pipe assembly must be tested in accordance with and meet the requirements for internal duct systems. (duct/pipe assembly consists of all components internal to the diaphragm concrete). Test the assembly at 1.5 psi. (2) The duct and pipe assembly consisting of all external duct connections (welded duct splices, duct-pipe, etc.) and a grout vent must

comply with the following test. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five minutes with no more than 15 psi reduction in pressure. The length of the test pipe assembly for the second test is 15 feet.

**462-4.2.7.3 Internal Duct Systems:** Perform a system test of the assembly for compliance with the requirements of Chapter 4, Article 4.2, Stage 1 and Stage 2 Testing contained in FIB Technical Report, Bulletin 7, titled "Corrugated Plastic Duct for Internal Bonded Post-tensioning". For bar systems modify the system test length to 15 feet. For systems being tested for use in precast segmental construction, modify this test to include one duct coupler (or O-ring assembly) which is to be used at the segment joint.

Test the coupler for proper function by casting the coupler into a two part concrete test block using match cast techniques. Use blocks that are at least 12 inch x 12 inch x 12 inch. After the concrete has hardened, pull the blocks apart and clean the surface of any bond breaker materials. Using an external apparatus clamp the blocks together and maintain 40 psi pressure on the block cross-section during the pressure test. Do not apply epoxy between the blocks for this portion of the test. Pressurize the duct within the test block to 5 psi and lock-off the outside air source. The assembly must sustain a 5 psi internal pressure for five minutes with no more than a 0.5 psi reduction in pressure. Separate the duct coupler blocks from the duct system remove the clamping device and place a 1/16 inch layer of epoxy on the face of both blocks, clamp the blocks together and maintain a pressure of 40 psi on the block cross-section for 24 hours. Upon removal of the clamping force, demolish the blocks. The coupler and the attached ducts should be intact and free of epoxy, and properly attached without crushing, tearing or other signs of failure.

**462-4.3 Grout:** Use only grouts that are on the Department's Qualified Products List (QPL) meeting the requirements of Section 938. Select the post-tensioning grout for use by the proper application either repair, horizontal or vertical. Grout will be mixed with potable water meeting the requirements of Section 923. Maintain grout fluidity in strict compliance with the grout manufacturer's recommendations and test with a flow cone.

**462-4.3.1Grout Storage:** Store grout in a location that is both dry and convenient to the work. Storage in the open must be on a raised platform and with adequate waterproof covering to protect the material. On site storage of grout is limited to a maximum period of one month.

**462-4.4 Samples for Testing and Identification:**

**462-4.4.1 General:** Testing must conform to the applicable ASTM Specifications for the prestressing material used.

Furnish all material samples for testing at no cost to the Department.

Consider the job site or site referred to herein, as the location where the prestressing steel is to be installed, whether at the bridge site or at the casting yard.

**462-4.4.2 Prestressing Steel:** Furnish samples for testing as described below for each manufacturer of prestressing strand and bar to be used on the project.

With each sample of prestressing steel strand or bar furnished for testing, submit a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

The Engineer will sample the following materials, at the plant or jobsite, from the prestressing steel used for post-tensioning operations:

(a) For strand: three randomly selected samples, 5 feet long, per manufacturer, per size of strand, per shipment, with a minimum of one sample for every ten reels delivered.

(b) For bars: three randomly selected samples, 5 feet long, per manufacturer, per size of bar, per heat of steel, with a minimum of one sample per shipment.

One of each of the samples furnished to represent a LOT, will be tested. The remaining sample(s), properly identified and tagged, will be stored by the Engineer for future testing. In the event of loss or failure of the component the stored sample will be utilized to evaluate for minimum strength requirements. For acceptance of the LOT represented, test results must show 100% of the guaranteed ultimate tensile strength.

**462-4.4.3 LOTs and Identification:** A LOT is that parcel of components as described herein. All bars, of each size from each mill heat of steel, and all strand from each manufactured reel to be shipped to the site must be assigned an individual LOT number and must be tagged in such a manner that each such LOT can be accurately identified at the job site. Submit records to the Engineer identifying assigned LOT numbers with the heat, or reel of material represented. All unidentified prestressing steel, or bars received at the site will be rejected. Also, loss of positive identification of these items at any time will be cause for rejection.

Provide a copy of the grout Quality Control Data Sheet to the Engineer, from the manufacturer, for each LOT number and shipment sent to the job site. Materials with a total time from manufacturer, in excess of six months, must be retested and certified by the supplier before use or be removed from the project and replaced.

**462-4.5 Approval of Materials:** The approval of any material by the Engineer will not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

SUBARTICLE 462-11.5.4 (of the Supplemental Specifications) is deleted and the following substituted:

**462-11.5.4 Grout Production Test:** During grouting operations the fluidity of the grout must be strictly maintained within the limits established by the grout manufacturer. A target fluidity rate will be established by the manufacturer's representative, based on ambient weather conditions. Determine grout fluidity by use of either test method found in Section 938. Perform fluidity test for each tendon to be grouted and maintain the correct water to cementitious ratio. Do not use grout which tests outside the allowable flow rates.

Prior to grouting empty ducts condition the grout materials as required to limit the grout temperature at the inlet end of the grout hose to 90°F. Prior to performing repair grouting operations with vacuum grouting, condition the grout

materials to limit the grout temperature at the inlet end of the grout hose to 85°F. Check the temperature of the grout at the inlet end of the grout hose hourly.

At the beginning of each day's grouting operation, *obtain a representative sample of grout from the first production batch of grout and* perform a wick induced bleed test in accordance with Section 938 *using this sample*. *Begin grouting operations after the sample is obtained.* If zero bleed is not achieved *in the wick induced bleed test* at *any time during* ~~the end of~~ the required *test* time period, *complete the grouting of any partially grouted tendons and* do not begin grouting of any new or additional tendons until the grouting operations have been adjusted and further testing shows the grout meets the specified requirements.

SUBARTICLE 462-12.1 (of the Supplemental Specifications) is deleted and the following substituted:

**462-12 Forming and Repairs of Holes and Block-Outs.**

**462-12.1 Repair of Lifting and Access Holes:** Repair all holes with Magnesium Ammonium Phosphate Concrete meeting the requirements of Section 930. Immediately before casting the concrete (within 24 hrs.), mechanically clean and roughen the mating concrete surfaces to remove any laitance and expose the small aggregate. Grit blasting or water blasting using a minimum 10,000 psi nozzle pressure is required. Flush surface with water and blow dry. Form, mix, place and cure the material in strict compliance with the manufacture*r*'s recommendations.

Upon completion of the deck grooving, coat the repaired holes, block-outs and an area extending 6 inches outside the perimeter of the repair with *a High Molecular Weight Methacrylate (HMWM) listed on the Qualified Products List. Prepare the surface to be coated and apply the HMWM in accordance with Section 413.* ~~Methyl Methacrylate. Apply and remove any excess material as per manufacturer's instructions.~~ *Friction (skid) tests per Section 413 are not required.*

Alternately, a Type Q Epoxy grout meeting the requirements of Section 926 may be used for the repair material.

**POST-TENSIONING - MATERIALS.**
**(REV 1-14-09)**

ARTICLE 462-4 (of the Supplemental Specifications) is deleted and the following substituted:

**462-4 Materials.**

Meet the requirements of following:

| | |
|---|---|
| Wire Strand* | ASTM A 416 |
| Bar** | ASTM A 722 |
| Water | Section 923 |
| Grout | Section 938 |
| Epoxy Grout | Section 926 |
| Magnesium Ammonium Phosphate Concrete | Section 930 |
| Elastomeric Coating System | Section 975 |
| Methacrylate | Section 413 |

**462-4.1 Prestressing Steel:**

(a) Strand: Unless otherwise noted on the plans, use uncoated strand meeting requirements of Section 933 (Grade 270, low relaxation 7-wire strand meeting the requirements of ASTM A 416).

(b) Bar: Unless otherwise noted on the plans, uncoated Grade 150, high strength, coarse thread bar meeting the requirements of ASTM A 722, Type II.

**462-4.2 Post-Tensioning System:** Use approved post-tensioning systems, of the proper size and type to construct tendons shown on the Contract Documents. Substitution of components of approved post-tensioning systems is not permitted. For permanent applications, the use and location of bar couplers is subject to approval by the Engineer. Use only post-tensioning systems that utilize tendons fully encapsulated in anchorages and ducts. Systems which transfer prestress force by bonding the prestress steel strand directly to concrete are not permitted. Embedded anchors for bars are permitted. Systems utilizing formed, ungrouted voids or “Diablos” are not permitted. Strand or tendon couplers are not permitted.

**462-4.2.1 Post-Tensioning Anchorages:** Ensure that the anchorages develop at least 95% of the actual ultimate tensile strength of the prestressing steel, when tested in an unbonded state, without exceeding the anticipated set.

Design anchorages so that the average concrete bearing stress is in compliance with the “AASHTO LRFD Bridge Design Specifications”. Test and provide written certification that anchorages meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications.

Galvanize the embedded body of the anchorage in accordance with ASTM 123. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. Construct the bearing surface and wedge plate from ferrous metal. Equip all anchorages with a permanent grout cap that is vented and bolted to the anchorage.

Provide wedge plates with centering lugs or shoulders to facilitate alignment with the bearing plate.

Cast anchorages with grout outlets suitable for inspection from either the top or front of the anchorage. The grout outlet will serve a dual function of grout outlet and post-grouting inspection access. The geometry of the grout outlets must facilitate being drilled using a 3/8” diameter straight bit to facilitate endoscope inspection directly behind the anchor plate. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type each providing singular inspection entry locations.

Trumpets associated with anchorages will be made of either ferrous metal or polypropylene plastic material conforming to the requirements stated in 462-4.2.5.5. The thickness of the trumpet at the transition location (choke point) will not be less than the thickness of the duct as established in 462-4.2.5.5. Alternately, the trumpet material may be polyolefin containing antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of not less than 20 minutes. Perform OIT test on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F 2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours.

**462-4.2.2 Bar Couplers:** Use couplers meeting the requirements of AASHTO LRFD Bridge Design Specifications and Bridge Construction Specifications. Test and provide written certification that the couplers meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications.

**462-4.2.3 Inlets, Outlets, Valves and Plugs:** Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A 240 Type 316 stainless steel, nylon or polyolefin materials. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Products made from polyolefin shall contain antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of not less than 20 minutes. Perform OIT test on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F 2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours. All inlets and outlets will be equipped with pressure rated mechanical shut-off valves or plugs. Inlets, outlets, valves and plugs will be rated for a minimum pressure rating of 150 psi. Use inlets and outlets with a minimum inside diameter of 3/4 inch for strand and 3/8 inch for single bar tendons and four-strand duct.

Provide dual mechanical shutoff valves when performing vertical grouting. Specifically designate temporary items, not part of the permanent structure, on the PT System drawings. Temporary items may be made of any suitable material.

**462-4.2.4 Permanent Grout Caps:** Use permanent grout caps made from approved polymer or ASTM A 240 Type 316L stainless steel. The approved resins used in the polymer shall be nylon, Acrylonitrile Butadiene Styrene (ABS) or polyester. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Seal the cap with “O” ring seals or precision fitted flat gaskets placed against the bearing plate. Place a grout vent on the top of the cap. Grout caps must be rated for a minimum pressure rating of 150 psi. Use ASTM A 240 Type 316L stainless steel bolts to attach the cap to the anchorage. When stainless steel

grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel.

**462-4.2.5 Duct and Pipe:**

**462-4.2.5.1 General:** Use only plastic duct, steel pipe or a combination of plastic duct and steel pipe. Ensure that all connectors, connections and components of post-tensioning system hardware are air and water tight and pass the pressure test requirements herein. Use smooth plastic duct in all post-tensioning systems used for external tendons. Use corrugated plastic duct in all post-tensioning systems used for all internal tendons except where steel pipe is required.

**462-4.2.5.2 Duct or Pipe Minimum Diameter:** For prestressing bars, provide duct with a minimum internal diameter of at least 1/2 inch larger than the outside diameter, measured across the deformations. For prestressing bars with couplers, size the duct to be 1/2 inch larger than the diameter of the bar and/or coupler.

For multi-strand tendons, provide ducts with a minimum cross-sectional area 2 1/2 times the cross-sectional area of the prestressing steel.

**462-4.2.5.3 Connection Tolerance between Pipe and Duct:** Steel pipe and plastic duct may be connected directly to each other when the outside diameters do not vary more than ± 0.08 inch. Use a reducer when the diameters of the steel pipe and the plastic duct are outside of this tolerance.

**462-4.2.5.4 Steel Pipes:** Use galvanized schedule 40 steel pipes where shown in the plans and in all deviation blocks and diaphragms.

**462-4.2.5.5 Corrugated Plastic Duct:** Do not use ducts manufactured from recycled material. Use seamless fabrication methods to manufacture ducts.

Use corrugated duct manufactured from non-colored, unfilled polypropylene meeting the requirements of ASTM D4101 “Standard Specification for Polypropylene Plastic Injection and Extrusion Materials” with a cell classification range of PP0340B14541 to PP0340B67884. The duct shall be white in color containing antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of 20 minutes and containing a non-yellowing light stabilizer. Perform OIT test on samples from the finished product. Furnish duct with a minimum thickness as defined in the following table:

| Duct Shape | Duct Diameter | Duct Thickness |
|---|---|---|
| Flat | any size | 0.08 inch |
| Round | 0.9 inch | 0.08 inch |
| Round | 2.375 inches | 0.08 inch |
| Round | 3.0 inches | 0.10 inch |
| Round | 3.35 inches | 0.10 inch |
| Round | 4.0 inches | 0.12 inch |
| Round | 4.5 inches | 0.14 inch |

| Duct Shape | Duct Diameter | Duct Thickness |
|---|---|---|
| Round | 5.125 inches | 0.16 inch |
| Round | 5.71 inches | 0.16 inch |

**462-4.2.5.5.1 Testing Requirements for Corrugated Plastic Duct:** Ensure that the duct system components and accessories meet the requirements of Chapter 4, Articles 4.1 through 4.1.8 of International Federation of Structural Concrete (FIB) Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning” as modified herein.

The requirements in FIB Technical Report, Bulletin 7, are modified as follows: Conduct the lateral load resistance test (FIB 4.1.4), without the use of a duct stiffener plate, using a load of 150 lbs. for all sizes; Wear resistance of duct (FIB 4.1.7) must not be less than 0.06 inch for duct up to 3.35 inches in diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter; Bond length test (FIB 4.1.8) must achieve 40 % GUTS in a maximum length of 16 duct diameters.

**462-4.2.5.5.2 Minimum Bending Radius for Corrugated Plastic Duct:** In addition to the component testing stated herein, the manufacturer shall establish, through testing, the minimum bending radius for the duct. The test consist of a modified duct wear test as described in Chapter 4, Article 4.1.7 of FIB Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning”. The test apparatus shall be identical to the wear test apparatus with the same clamping force as a function of the number of strands in the duct; however, modify the procedure as follows: do not move the sample along the strand to simulate wear; the test duration will be 7 days. Upon completion of the test duration, remove the duct and the minimum wall thickness along the strand path must not be less than 0.06 inch for duct up to 3.35 inches diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter.

**462-4.2.5.5.3 Corrugated Duct Connections and Fittings:** Make all splices, joints, joints between segments (segmental construction), couplings and connections to anchorages with devices or methods (i.e. mechanical couplers, plastic sleeves in conjunction with shrink sleeve) producing a smooth interior alignment with no lips or kinks. Design all connections and fittings to be airtight. Duct tape is not permitted to join or repair duct connections.

Construct connections and fittings from polyolefin materials containing antioxidant stabilizer(s) meeting the requirements established in 462-4.2.3 or 462-4.2.5.5.

For post-tensioned systems intended for use with segmental constructed box girder bridges, the post-tensioning system shall include duct couplers at the segment joints. The tendon duct coupler located at the segment joint shall be mounted perpendicular to the bulkhead and designed to receive a duct at an angle of 6 degrees deviation from perpendicular. The coupler must be able to accommodate angular deviation of the duct without the tendon strands touching the duct or coupler on either side of the segment joint.

**462-4.2.5.6 Smooth Duct:** Use smooth duct manufactured from 100% virgin polyethylene resin meeting the requirements of ASTM D 3350 with a minimum cell class of 344464C. Use resin containing antioxidant(s). Perform OIT test on

samples taken from the finished product resulting in a minimum Oxidative Induction Time (OIT) according to ASTM D 3895 of 40 minutes. Manufacture duct with a dimension ratio (DR) of 17.0 or less as established by either ASTM D 3055 or ASTM F 714 as appropriate for the manufacturing process used.

Use smooth duct meeting the minimum pressure rating (working pressure) of 100 psi and manufactured to either of the following Specifications: ASTM D 3035 “Standard Specifications for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter” or ASTM F 714 “Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter”.

**462-4.2.5.6.1 External Smooth Duct Connections:** Use heat welding techniques to make splices between sections of plastic duct, in accordance with the duct manufacturers’ instructions or make connections with electrofusion coupler or other mechanical couplers meeting the material requirements of this Specification. Ensure all connections have a minimum pressure rating (working pressure) of 100 psi, produce a smooth interior alignment and a connection with no lips or kinks.

Ensure all connections between steel pipe embedded in concrete and plastic duct are made by using a mechanical coupler or a circular sleeve made of Ethylene Propylene Deine Monomer (EPDM), having a minimum pressure rating (working pressure) of 100 psi. Use EPDM materials having 100 % quality retention as defined by ASTM D 1171 Ozone Chamber Exposure Method B.

Use EPDM sleeves having a minimum wall thickness of 3/8 inch and be reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide power seated band and clamps constructed from 316 stainless steel on each end of the boot to seal against leakage of grout. Install the band with an 80 to 120 lb seating force.

**462-4.2.5.7 Corrugated Ferrous Metal Ducts:** Do not use corrugated ferrous metal ducts in any location.

**462-4.2.5.8 Shipping and Storage of Ducts:** Furnish duct with end caps to seal the duct interior from contamination. Ship in bundles which are capped and covered during shipping and storage. Protect ducts against ultraviolet degradation, crushing, excessive bending, dirt contamination and corrosive elements during transportation, storage and handling. Do not remove end caps supplied with the duct until the duct is incorporated into the bridge component. Store duct in a location that is dry and protected from the sun. Storage must be on a raised platform and completely covered to prevent contamination. If necessary, wash duct before use to remove any contamination.

**462-4.2.6 Internal Duct Mechanical Couplers, O-Rings, Segment Seal Assemblies and Heat Shrink Sleeve Requirements:** Ducts for prestressing bars used exclusively for temporary post-tensioning are not required to be coupled across segment joints.

**462-4.2.6.1 Mechanical Couplers:** Construct mechanical internal duct couplers with stainless steel, plastic or a combination of these materials. Use plastic resins meeting the requirements for of sections 462-4.2.3 or 462-4.2.5.5 to construct plastic couplers. Use ASTM A 240 Type 316 stainless steel to make metallic components.

**462-4.2.6.2 O-rings:** Provide O-ring duct coupling assemblies and **s**egment seal mounting assemblies made from plastic resins meeting the requirements of sections 462-4.2.3 or 462-4.2.5.5.

Furnish standard O-ring material (diameter $\leq$ 0.25 inch) conforming with the following requirements:

**Mechanical Properties**

Shore hardness, A ASTM D2240 ..... 50-75
Ultimate elongation %, ASTM D412 .....250 % Min.
Tensile strength, ASTM D412..... 1400 psi Min.

**Accelerated Testing**

Thermal Deterioration 70 hours @ 257$^{o}$ F, ASTM D573
Change in tensile strength.....± 30 %
Change of elongation.....-50 %
Change of hardness.....± 15 points
Compression Set Method B 22 hours @257$^{o}$ F, ASTM D395..... 50 %
Volume change due to absorption of $H_2O$, Method D, for 70 hours @ 212$^{o}$ F, ASTM D471.....+ 10 %

**Environmental Resistance**

Ozone Resistance Exposure Method B, ASTM D1171..... Pass
Low Temp. Non-brittle after 3 Min. @ -40$^{o}$F, ASTM D2137..... Pass

Furnish segment seal assemblies for large diameter compression seals, used to couple ducts at segment joints, which conform with the requirements stated above and with the following additions and changes:

**Mechanical Properties**

Shore hardness, A ASTM D2240 ..... 30-40
Tensile strength, ASTM D412..... 600 psi Min.
Compression Set Method B 22 hours @257$^{o}$ F, ASTM D395..... 60 %

**Compression Force -** The maximum force to compress the O-ring to its final compressed position shall not be greater than 25 psi times the area encircled by the O-ring.

**Voided Area -** The seal shall be designed to accommodate the material flow within its own cross sectional area by using a hollow or voided design.

**Mounting Assemblies -** Assemblies holding the O-ring must mount to the form bulkhead and provide for duct alignment.

**462-4.2.6.3 Heat Shrink Sleeves:** Furnish heat shrink sleeves having unidirectional circumferential recovery manufactured specifically for the size of the duct being coupled consisting of an irradiated and cross linked high density polyethylene backing for external applications and linear-density polyethylene for internal applications. Furnish adhesive having the same bond value to steel and polyolefin plastic materials. Ensure the heat shrink sleeves have an adhesive layer that will withstand 150° F operating temperature and meet the requirements of the following table:

| Property | Test Method | Minimum Requirements | |
|---|---|---|---|
| | | Internal Application | External Application |
| Minimum Fully Recovered Thickness | | 92 mils | 111 mils |
| Peel Strength | ASTM D 1000 | 29 pli | 46 pli |
| Softening Point | ASTM E 28 | 162°F | 216°F |
| Lap Shear | DIN 30 672M | 87 psi | 58 psi |
| Tensile Strength | ASTM D 638 | 2,900 psi | 3,480 psi |
| Hardness | ASTM D 2240 | 46 Shore D | 52 Shore D |
| Water Absorption | ASTM D 570 | Less than 0.05% | Less than 0.05% |
| Color | | Yellow | Black |
| Minimum Recovery | Heat Recovery Test | 33% | 23% |

Install heat shrink sleeves using procedures and methods in accordance with the manufacturer's recommendations.

**462-4.2.7 System Test Requirements:** For each family of post-tensioning systems, assemble systems and perform the pressure test defined herein. For each family of post-tensioning systems test two assemblies (largest and smallest) from the family. The post-tensioning assembly includes at least one of each component required to make a tendon from grout cap to grout cap. If applicable, include plastic duct to steel pipe connections and segment duct couplers.

**462-4.2.7.1 Grouting Component Assembly Pressure Test:** Assemble anchorage and grout cap with all required grouting attachments (grout tube, valves, plugs, etc.). Seal the opening in the anchorage where the duct connects. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five minutes with no more than 15 psi reduction in pressure. For systems using the same anchorages, grout caps and grouting attachments as a previously approved system, the Grouting Component Assembly Pressure Test may include documentation from a previous submittal with written certification that the same components are being utilized in both anchorages.

**462-4.2.7.2 External Duct Systems:** System testing for external duct requires two additional tests. (1) The anchorage and its connection to the duct/pipe assembly must be tested in accordance with and meet the requirements for internal duct systems. (duct/pipe assembly consists of all components internal to the diaphragm concrete). Test the assembly at 1.5 psi. (2) The duct and pipe assembly consisting of all external duct connections (welded duct splices, duct-pipe, etc.) and a grout vent must

comply with the following test. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five minutes with no more than 15 psi reduction in pressure. The length of the test pipe assembly for the second test is 15 feet.

**462-4.2.7.3 Internal Duct Systems:** Perform a system test of the assembly for compliance with the requirements of Chapter 4, Article 4.2, Stage 1 and Stage 2 Testing contained in FIB Technical Report, Bulletin 7, titled "Corrugated Plastic Duct for Internal Bonded Post-tensioning". For bar systems modify the system test length to 15 feet. For systems being tested for use in precast segmental construction, modify this test to include one duct coupler (or O-ring assembly) which is to be used at the segment joint.

Test the coupler for proper function by casting the coupler into a two part concrete test block using match cast techniques. Use blocks that are at least 12 inch x 12 inch x 12 inch. After the concrete has hardened, pull the blocks apart and clean the surface of any bond breaker materials. Using an external apparatus clamp the blocks together and maintain 40 psi pressure on the block cross-section during the pressure test. Do not apply epoxy between the blocks for this portion of the test. Pressurize the duct within the test block to 5 psi and lock-off the outside air source. The assembly must sustain a 5 psi internal pressure for five minutes with no more than a 0.5 psi reduction in pressure. Separate the duct coupler blocks from the duct system remove the clamping device and place a 1/16 inch layer of epoxy on the face of both blocks, clamp the blocks together and maintain a pressure of 40 psi on the block cross-section for 24 hours. Upon removal of the clamping force, demolish the blocks. The coupler and the attached ducts should be intact and free of epoxy, and properly attached without crushing, tearing or other signs of failure.

**462-4.3 Grout:** Use only grouts that are on the Department's Qualified Products List (QPL) meeting the requirements of Section 938. Select the post-tensioning grout for use by the proper application either repair, horizontal or vertical. Grout will be mixed with potable water meeting the requirements of Section 923. Maintain grout fluidity in strict compliance with the grout manufacturer's recommendations and test with a flow cone.

**462-4.3.1Grout Storage:** Store grout in a location that is both dry and convenient to the work. Storage in the open must be on a raised platform and with adequate waterproof covering to protect the material. On site storage of grout is limited to a maximum period of one month.

**462-4.4 Samples for Testing and Identification:**

**462-4.4.1 General:** Testing must conform to the applicable ASTM Specifications for the prestressing material used.

Furnish all material samples for testing at no cost to the Department.

Consider the job site or site referred to herein, as the location where the prestressing steel is to be installed, whether at the bridge site or at the casting yard.

**462-4.4.2 Prestressing Steel:** Furnish samples for testing as described below for each manufacturer of prestressing strand and bar to be used on the project.

With each sample of prestressing steel strand or bar furnished for testing, submit a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

The Engineer will sample the following materials, at the plant or jobsite, from the prestressing steel used for post-tensioning operations:

(a) For strand: three randomly selected samples, 5 feet long, per manufacturer, per size of strand, per shipment, with a minimum of one sample for every ten reels delivered.

(b) For bars: three randomly selected samples, 5 feet long, per manufacturer, per size of bar, per heat of steel, with a minimum of one sample per shipment.

One of each of the samples furnished to represent a LOT, will be tested. The remaining sample(s), properly identified and tagged, will be stored by the Engineer for future testing. In the event of loss or failure of the component the stored sample will be utilized to evaluate for minimum strength requirements. For acceptance of the LOT represented, test results must show 100% of the guaranteed ultimate tensile strength.

**462-4.4.3 LOTs and Identification:** A LOT is that parcel of components as described herein. All bars, of each size from each mill heat of steel, and all strand from each manufactured reel to be shipped to the site must be assigned an individual LOT number and must be tagged in such a manner that each such LOT can be accurately identified at the job site. Submit records to the Engineer identifying assigned LOT numbers with the heat, or reel of material represented. All unidentified prestressing steel, or bars received at the site will be rejected. Also, loss of positive identification of these items at any time will be cause for rejection.

Provide a copy of the grout Quality Control Data Sheet to the Engineer, from the manufacturer, for each LOT number and shipment sent to the job site. Materials with a total time from manufacturer, in excess of six months, must be retested and certified by the supplier before use or be removed from the project and replaced.

**462-4.5 Approval of Materials:** The approval of any material by the Engineer will not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

SUBARTICLE 462-11.5.4 (of the Supplemental Specifications) is deleted and the following substituted:

**462-11.5.4 Grout Production Test:** During grouting operations the fluidity of the grout must be strictly maintained within the limits established by the grout manufacturer. A target fluidity rate will be established by the manufacturer's representative, based on ambient weather conditions. Determine grout fluidity by use of either test method found in Section 938. Perform fluidity test for each tendon to be grouted and maintain the correct water to cementitious ratio. Do not use grout which tests outside the allowable flow rates.

Prior to grouting empty ducts condition the grout materials as required to limit the grout temperature at the inlet end of the grout hose to 90°F. Prior to performing repair grouting operations with vacuum grouting, condition the grout

materials to limit the grout temperature at the inlet end of the grout hose to 85°F. Check the temperature of the grout at the inlet end of the grout hose hourly.

At the beginning of each day's grouting operation, obtain a representative sample of grout from the first production batch of grout and perform a wick induced bleed test in accordance with Section 938 using this sample. Begin grouting operations after the sample is obtained. If zero bleed is not achieved in the wick induced bleed test at any time during the required test time period, complete the grouting of any partially grouted tendons and do not begin grouting of any new or additional tendons until the grouting operations have been adjusted and further testing shows the grout meets the specified requirements.

SUBARTICLE 462-12.1 (of the Supplemental Specifications) is deleted and the following substituted:

**462-12 Forming and Repairs of Holes and Block-Outs.**

**462-12.1 Repair of Lifting and Access Holes:** Repair all holes with Magnesium Ammonium Phosphate Concrete meeting the requirements of Section 930. Immediately before casting the concrete (within 24 hrs.), mechanically clean and roughen the mating concrete surfaces to remove any laitance and expose the small aggregate. Grit blasting or water blasting using a minimum 10,000 psi nozzle pressure is required. Flush surface with water and blow dry. Form, mix, place and cure the material in strict compliance with the manufacturer's recommendations.

Upon completion of the deck grooving, coat the repaired holes, block-outs and an area extending 6 inches outside the perimeter of the repair with a High Molecular Weight Methacrylate (HMWM) listed on the Qualified Products List. Prepare the surface to be coated and apply the HMWM in accordance with Section 413. . Friction (skid) tests per Section 413 are not required. Alternately, a Type Q Epoxy grout meeting the requirements of Section 926 may be used for the repair material.