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M E M O R A N D U M

DATE: June 2, 2015

TO: Specification Review Distribution List

FROM: Daniel Scheer, P.E., State Specifications Engineer

SUBJECT: Proposed Specification: **9600000 Post-Tensioning Components.**

In accordance with Specification Development Procedures, we are sending you a copy of a proposed specification change.

This change was proposed by Charles Boyd of the State Structures Design Office to modify the language to allow for use of flexible filler in post-tensioning applications. Revisions to include flexible filler are also proposed for Sections 105, 452, 462, and 938.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or online at http://www2.dot.state.fl.us/ProgramManagement/Development/IndustryReview.aspx . Comments received after **June 30, 2015,** may not be considered. Your input is encouraged.

DS/dt
Attachment

POST-TENSIONING COMPONENTS.
(REV 5-~~11~~~~3~~18-15)

SECTION 960 is deleted and the following substituted:

SECTION 960
POST-TENSIONING COMPONENTS

960-1 Description.

This Section covers all post-tensioning (PT) components remaining in a completed structure, including temporary erection PT left in-place and permanent PT for design capacity.

Manufacturers seeking approval of PT systems for inclusion on the Structures Design Office (SDO) list of Approved Post-Tensioning Systems must use materials and components meeting requirements of this Section and Section 462. Submit a complete PT System Application Package including component drawings, system drawings, and test reports from a certified laboratory (or laboratories), as defined in 960-3.1, to the SDO for review, acceptance and inclusion on the list of Approved Post-Tensioning Systems.

Any marked variations from original test values or any evidence of inadequate field performance of a PT system, will result in the PT System being removed from the list of Approved Post-Tensioning Systems.

960-1.1 Material References:

Meet the requirements of this Section and the following:

Epoxy Compounds.....Section 926*
Bar (post-tensioning) .....Section 933
Duct Filler for Post Tension~~ing~~ed ~~Grout~~Structures ...Section 938*
Reinforcing Steel (mild) .....Section 415
Parallel Wire~~/~~ (post-tensioning).....Section 933
Strand (post-tensioning).....Section 933
*Use products listed on the Department's Approved Product List (APL).

960-2 Component Standards.

Substitution, modification, or deletion of components of PT systems as shown on the SDO website for Approved Post-Tensioning Systems, excluding local zone reinforcement, is not permitted. Inclusion of all possible subcomponents is required for PT system and component testing; however, subcomponents of approved systems may be eliminated from final installations based on project specific requirements, provided all component-to-component interface hardware are included as necessary to maintain connections and PT system integrity.

Provide only PT systems utilizing tendons completely encapsulated in grout~~-~~ or flexible filler filled anchorages and ducts. Do not use systems transferring prestress force by bonding prestress steel strand directly to concrete. Embedded anchorages for bars are permitted. ~~Systems utilizing formed, un-grouted voids, or "Diabolos," are not permitted.~~ Strand or strand-tendon couplers are not permitted.

Stamp all components of a PT system with the suppliers name, trademark, model number, and size corresponding to catalog designation.

All miscellaneous hardware components, including but not limited to splices, joints, duct couplers, connections, inlets, outlets, drains, valves, and plugs, are part of approved PT systems.

960-2.1 Anchorage Assembly:

~~(a)~~1. Construct anchorages from ferrous metal.

~~(b)~~2. Anchorages shall develop at least 9~~5~~6% of PT steel ~~guaranteed~~actual ultimate ~~tensile~~ strength ~~(GUTS)~~ when tested in an unbonded state, without exceeding anticipated anchor set.

~~(c)~~3. Average concrete bearing stress shall be in compliance with AASHTO LRFD Bridge Design Specifications and ~~"~~AASHTO LRFD Bridge Construction Specifications.~~"~~

~~(d)~~4. Test anchorages with typical local zone reinforcement shown in system drawings.

~~(e)~~5. In addition, test anchorages that will be used for tendons with flexible filler in accordance with the AASHTO LRFD Bridge Construction Specifications requirements for Post-Tensioning Anchorages and Couplers, Unbonded Systems.

6. Anchorages with grout or flexible filler outlets shall be suitable for inspection from either top or front of anchorage. 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.

~~(f)~~7. Geometry of grout and flexible filler outlets must facilitate access for ~~endo~~borescope inspection directly behind wedge plate using a straight 3/8 inch diameter drill bit.

~~(g)~~8. Ferrous metal components of an anchorage that are to be embedded in concrete shall be galvanized in accordance with Section 962. Other anchorage assembly components, including wedges, wedge plates, and local zone reinforcement need not be galvanized.

~~(h)~~9. All anchorages shall have a permanent vented anchorage cap bolted to the anchorage.

960-2.1.1 Trumpets:

~~(a)~~1. Trumpets associated with anchorages shall be constructed from ferrous metal galvanized per ASTM A123, polypropylene plastic, or polyolefin.

~~(b)~~2. Trumpet thickness at transition location shall be the thickness of the duct or greater.

960-2.1.2 Wedges and Wedge Plates:

~~(a)~~1. Wedge plate shall be ferrous metal.

~~(b)~~2. Wedge plates must have centering lugs or shoulders to facilitate alignment with bearing plate.

~~(c)~~3. For longitudinal tendons greater than four strands, design system with separate wedge plate and anchorage plate.

960-2.2 ~~Grout~~ Filler Containment Assembly:

960-2.2.1 Duct and Pipe:

~~(a)~~1. Use plastic duct, steel pipe, or a combination of plastic duct and steel pipe in accordance with this Section.

~~(b)~~2. Ducts shall be manufactured by a seamless fabrication method. Fabricate all duct splices to prevent kinks during all phases of construction.

~~(c)~~3. Do not alter the natural duct color that results from UV protected polymer.

~~(d)~~4. Corrugated ferrous metal ducts are prohibited.

960-2.2.1.1 ~~Internal Duct (~~Corrugated Plastic~~)~~ Duct:

~~(a)~~1. PT systems ~~used for tendons internal to concrete~~ with duct injected with grout shall use corrugated polypropylene plastic material except where steel pipe is required.

~~(b)~~2. Furnish ducts with minimum wall thickness as follows:

Table 2.2.1.1-1: Corrugated Plastic Duct Minimum Wall Thicknesses

Table 2.2.1.1-1: Corrugated Plastic Duct Minimum Wall Thicknesses		
Duct Shape	Duct Diameter	Duct Thickness
Flat	Any Size	0.08 inch
Round	0.9 inch	0.08 inch
Round	2.375 inch	0.08 inch
Round	3.0 inch	0.10 inch
Round	3.35 inch	0.10 inch
Round	4.0 inch	0.12 inch
Round	4.5 inch	0.14 inch
Round	5.125 inch	0.16 inch
Round	5.71 inch	0.16 inch

960-2.2.1.2 ~~External Duct (~~Smooth Plastic~~)~~ Duct:

~~(a)~~1. PT systems ~~for tendons external to concrete~~ with duct injected with flexible filler shall use smooth plastic duct.

~~(b)~~2. ~~External PT system d~~Duct shall be polyethylene resin material.

~~(c)~~3. Duct shall have a maximum dimension ratio (DR) of 17 as established by either ASTM D3035 or ASTM F714, as appropriate for manufacturing process used.

~~(d)~~4. ~~Smooth d~~Duct shall have a minimum pressure rating of ~~100~~ 125 psi.

960-2.2.1.3 Steel Pipe:

Where specified in the Contract Documents ~~and in all deviation blocks~~, steel pipes shall be Schedule 40 and galvanized in accordance with Section 962.

960-2.2.1.4 Minimum Internal Diameter:

~~(a)~~1. For prestressing bars, duct shall have a minimum internal diameter of 1/2 inches larger than bar outside diameter, measured across deformations.

~~(b)~~2. For prestressing bars with couplers, duct shall have a minimum internal diameter of 1/2 inches larger than largest dimension of the largest enclosed element.

~~(c)~~3. For multi-strand tendons, ducts must have a minimum cross-sectional area 2-1/2 times PT steel cross-sectional area.

960-2.2.1.5 Connections, Fittings, and Tolerance:

~~(a)~~1. ~~Corrugated plastic duct connections shall be from polyolefin or polypropylene material.~~

~~(b)~~ Devices or methods ~~(e.g., mechanical duct couplers, plastic heat shrink sleeves)~~ for all duct connections (e.g., splices, joints, coupl~~ing~~ers, connection to anchorages), shall produce smooth interior alignment with no lips or kinks.

~~(c)~~2. Use of tape is not permitted to join or repair duct, to make connections, or for any other purpose.

3. Use a reducer when adjacent sections of duct are directly connected to each other and the outside diameters vary more than plus or minus 0.08 inch.

4. Provide all connections with a minimum pressure rating of 100 psi.

5. Use heat shrink sleeves and circular sleeve couplers made from polyolefin or polypropylene material, or duct couplers made from polyolefin or polypropylene material with O-rings or seals to make connections between sections of corrugated plastic duct or between corrugated plastic duct and trumpets.

6. Use heat shrink sleeves and circular sleeve couplers made from polyolefin or polypropylene material to make connections between corrugated plastic duct and steel pipe.

7. Use heat shrink sleeves with or without circular sleeve couplers made from polyolefin or polypropylene material to make connections between corrugated plastic duct and anchorages with integral trumpets.

~~(d)~~8. Use ~~H~~heat welding techniques, ~~to make splices between sections of smooth plastic duct or to make connections with~~ electrofusion duct couplers, or ~~other mechanical duct couplers is permitted~~ Ethylene Propylene Diene Monomer (EPDM) sleeves and stainless steel band clamps to make connections between sections of smooth plastic duct.

~~(e)~~ 9. ~~For external tendons, mechanical duct coupler or a circular sleeve made of Ethylene Propylene Diene Monomer~~Use ~~(~~EPDM~~)~~ ~~material shall be used~~ sleeves and stainless steel band clamps to make ~~all~~ connections between smooth plastic duct and steel pipe.

~~(f)~~10. Use ~~a reducer when adjacent sections of duct are directly connected to each other and the outside diameters vary more than plus or minus 0.08 inch~~Use welding or EPDM sleeves and stainless steel band clamps to make connections between sections of steel pipe that are external to the concrete.

~~(g)~~11. ~~Provide all connections with a minimum pressure rating of 100 psi~~Use welding, EPDM sleeves and stainless steel band clamps or heat shrink sleeves and circular sleeve couplers made from polyolefin or polypropylene material to make connections between steel pipe and trumpets that are internal to the concrete.

~~(h)~~12. ~~Provide~~ Use EPDM sleeves with a minimum wall thickness of 3/8 inches and reinforced with a minimum of four ply polyester reinforcement.

~~(i) To connect EPDM duct couplers, u~~Use a 3/8 inch wide stainless steel power seated band and clamps on each end of the EPDM ~~duct couplers and circular~~ sleeves to secure the sleeves to plastic ducts or steel pipes. Seat the ~~B~~bands ~~capacity at installation must~~ with~~stand~~ a 120 pounds ~~seating~~ force~~.~~ prior to clamping them in place.

960-2.2.1.6 Segmental Duct Couplers:

~~(a)~~1. Include segmental duct couplers ~~at joints of~~ for permanent internal PT systems at joints between match cast precast segments.

~~(b)~~2. ~~Mechanical internal duct couplers shall be stainless steel, plastic, or a combination of these materials~~Use “O”- rings or compression seals between adjoining sections of segmental duct couplers.

~~(c)~~3. Plastic duct couplers shall be polyolefin or polypropylene material.

~~(d)~~4. Metallic components ~~must~~ shall be stainless steel per 960-2.4.3.

~~(e)~~5. Segmental duct couplers shall mount perpendicular to the bulkhead at segment joints and provide for duct alignment.

~~(f)~~6. Segmental duct couplers shall be able to receive duct at an angle of 6 degree deviation from perpendicular.

~~(g)~~7. Segmental duct couplers must be able to accommodate angular deviation of duct without tendon strands touching duct or coupler on either side of segment joint.

~~(h)~~8. Ducts for prestressing, used exclusively for temporary erection PT that is to be removed from structure, are not required to be coupled across segment joints.

960-2.2.1.7 "O"-Rings:

~~(a)~~1. "O"-rings with cross section diameters less than or equal to 0.25 inches and compression seals for use with segmental duct couplers~~ assemblies and segment seal mounting assemblies shall be polyolefin material or polypropylene material.~~

~~(b) Standard "O"-ring material, for diameters less than or equal to 0.25 inches~~, anchorage caps and other similar components shall conform to the requirements of ~~the following t~~Table 2.2.1.7-1~~:~~.

Table 2.2.1.7-1 "O"-Ring and Compression Seal Material Properties (cross section diameter ≤ 0.25 in)	
Mechanical Properties	
Shore hardness, ASTM D2240	50-75
Ultimate elongation %, ASTM D412	250% min.
Tensile strength, ASTM D412	1400 psi min.
Accelerated Testing	
Thermal Deterioration 70 hours @ 257° F, ASTM D573	
Change in tensile strength	± 30%
Change of elongation	-50%
Change of hardness	± 15 points
Compression Set Method B 22 hours @ 257° F, ASTM D395	50%
Volume change due to absorption of H_2O, Method D, for 70 hours @ 212°F, ASTM D 471	+ 10%
Environmental Resistance	
Ozone Resistance Exposure Method B, ASTM D1171	Pass
Low Temp. Non-brittle after 3 Min. @ -40°F, ASTM D2137	Pass

~~(c)~~2. ~~Segment seal assemblies for~~ "O"-rings and compression seals with diameters greater than 0.25 inches~~,~~ for used~~ to couple ducts at~~ with segmental ~~joints~~duct couplers, anchorage caps and other similar components, shall conform to the requirements in Table 2.2.1.7-1 with the additions and modifications in ~~the following t~~Table 2.2.1.7-2~~:~~.

Table 2.2.1.7-2 Large Diameter "O"-Rings and Compression Seals (cross section diameter > 0.25 in)	
Mechanical Properties	
Shore hardness, ASTM D2240	30-60
Tensile strength, ASTM D412	600 psi min.
Compression Set Method B 22 hours @ 257° F, ASTM D395	60%

(d)43. **Compression Force** - Maximum force to compress an "O"-ring or compression seal to its final compressed position shall not be greater than 25 psi, times the area encircled by "O"-ring or seal.

(e)54. **Voided Area** - Compression Sseals must accommodate material flow within its own cross sectional area by using a hollow or voided design.

~~(f) **Mounting Assemblies** - Assemblies holding "O"-ring must mount to form bulkhead and provide for duct alignment.~~

960-2.2.1.8 Heat Shrink Sleeves:

(a)1. Heat shrink sleeves shall have unidirectional circumferential recovery and be sized specifically for duct size being coupled.

(b)2. Use irradiated and cross linked high density polyethylene backing for external applications and linear-density polyethylene for internal applications.

(c)3. Use adhesive with the same bond value to steel and polyolefin plastic materials.

(d)4. Heat shrink sleeves shall have an adhesive layer that meets the requirements of the following table:

Table 2.2.1.8-1 Heat Shrink Sleeve Adhesive Layer Minimum Requirements			
Property	Test Method	Minimum Requirements	
		Internal Application	External Application
Minimum Fully Recovered Thickness		92 to 126 mils	111 mils
Peel Strength	ASTM D 1000	29 pli	46 pli
Softening Point	ASTM E 28	162ºF	216ºF
Lap Shear	DIN 30 672M	87 psi	58 psi
Tensile Strength	ASTM D 638	2,900 to 3,480 psi	3,480 psi
Hardness	ASTM D 2240	46 to 48 Shore D	52 Shore D
Water Absorption	ASTM D 570	Less than 0.05%	Less than 0.05%
Color		Yellow or Black	Black
Minimum Recovery	Heat Recovery Test	33% to 58%	23%
Operating Temperature		125°F	150°F

(e)5. Install heat shrink sleeves using procedures and methods specified in the manufacturer's instructions.

960-2.2.2 Attachments:

960-2.2.2.1 Anchorage Caps:

~~(a)~~1. Provide permanent anchorage caps made of stainless steel, nylon, polyester, or Acrylonitrile Butadiene Styrene (ABS).

~~(b)~~2. Seal Anchorage cap with "O"-ring seals or precision fitted flat gaskets placed against the bearing plate.

~~(c)~~3. Place a vent hole of 3/8 inch minimum diameter suitable for ~~grout~~ filler venting and inspection of the content inside the anchorage cap from the top or front of the anchorage cap as appropriate (e.g. anchorage caps not accessible after ~~grouting~~ filler injection must have a vent at the top of the cap). Anchorage caps may be fabricated to facilitate both inspection locations.

~~(d)~~4. Anchorage caps shall have a minimum pressure rating of 150 psi.

~~(e)~~5. Stainless steel bolts shall be used to attach cap to anchorage.

~~(f)~~6. Certified test reports documenting steel chemical analysis shall be provided when stainless steel anchorage caps are used.

960-2.2.2.2 Inlets, Outlets, Drains, Valves, and Plugs:

~~(a)~~1. Provide permanent ~~grout~~ inlets, outlets, drains, valves, and threaded plugs made of nylon, polyolefin materials, or stainless steel.

~~(b)~~2. All inlets, ~~and~~ outlets, and drains shall have pressure rated mechanical shut-off valves or plugs.

~~(c)~~3. Inlets, outlets, drains, valves, and plugs shall have a minimum pressure rating of 150 psi.

~~(d)~~4. Inlets and outlets shall have a minimum inside diameter of 3/4 inches for strand and 3/8 inches for single bar tendons and four-strand ducts.

~~(e)~~5. Drains shall have a minimum inside diameter of 3/8 inches. Locate drains, and inlets and outlets serving as drains, at the bottom of the duct cross section.

6. Dual in-line mechanical shutoff valves are required for vertical ~~grouting~~ PT systems.

~~(f)~~7. Specifically designate temporary items, not part of the permanent structure, on PT system drawings.

960-2.3 Steel Reinforcing:

960-2.3.1 Mild:

~~(a)~~1. Reinforcing steel shall conform to Section 415 and Section 462.

~~(b)~~2. Test typical local zone reinforcement for compliance with AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications, as applicable. Include reinforcement details in system drawings submitted for system approval.

960-2.3.2 Prestressing:

960-2.3.2.1 Strand:

Prestressing strands shall be in accordance with Section 933.

960-2.3.2.2 Bar:

~~(a)~~1. Prestressing bars shall be in accordance with Section 933.

~~(b)~~2. Bar couplers shall be in compliance with AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications. Test bar couplers that will be used for tendons with flexible filler in accordance with the AASHTO LRFD Bridge Construction Specifications requirements for Post-Tensioning Anchorages and Couplers, Unbonded Systems.

~~(c)~~3. Use only spherical nuts to anchor bars at bearing plates.

960-2.4 PT System Materials:

~~(a)~~1. Use material specifications in this Section for all PT system components and subcomponents.

~~(b)~~2. Use only virgin material for all non-ferrous components. Do not use any components manufactured from recycled material unless the manufacturer provides data supporting the material performance and oxidation properties meet or exceed that of virgin material.

~~(c)~~3. Test only samples taken from finished product as applicable.

960-2.4.1 Nylon:

Use one of the following cell classes according to ASTM D5989:

~~(a)~~1. S-PA0141 – weather resistant.

~~(b)~~2. S-PA0231 – heat stabilized.

~~(c)~~3. S-PA0401 – ultimate strength not less than 10,000 psi with UV stabilizer added.

960-2.4.2 Polyolefin:

Conforms to both of the following:

~~(a)~~1. Contains antioxidants with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes.

~~(b)~~2. Remolded finished material has a minimum failure time of three hours when tested for stress crack resistance using ASTM F2136 at an applied stress of 348 psi.

960-2.4.3 Stainless Steel:

Conforms to the following:

~~(a)~~1. ASTM A240 Type 316 - for metallic components other than bolts.

~~(b)~~2. ASTM F593 Type 316 - for bolts.

960-2.4.4 Polypropylene:

Conforms to all of the following:

~~(a)~~1. Non-colored, unfilled polypropylene according to ASTM D4101 with a cell class range of PP0340B44541 to PP0340B67884.

~~(b)~~2. Contains antioxidants with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes.

~~(c)~~3. Contains a non-yellowing light stabilizer.

960-2.4.5 Polyethylene Resin:

Conforms to all of the following:

~~(a)~~1. Meets requirements of ASTM D3350 with a minimum cell class of ~~344464~~445574C.

~~(b)~~2. Contains antioxidants with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of 40 minutes.

960-2.4.6 Ethylene Propylene Diene Monomer (EPDM):

Meets requirements of ASTM D1171 using Ozone Chamber Exposure Method B (no cracks permitted under 2X magnification).

960-3 System Pre-Approval Requirements.

960-3.1 Independent Testing:

Use independent laboratories meeting the credentials described in this Section to perform all testing and to provide certified test reports for materials and components.

Certification may be performed by a qualified independent laboratory outside of the United States, only if the facility is pre-approved by the State Materials Office.

Conform all testing procedures used for materials or components to applicable American Society of Testing and Materials (ASTM) and International Federation of Structural Concrete (fib) Specifications or as modified in this Section.

960-3.1.1 Material Laboratory:

Test plastic components in a certified independent laboratory accredited through the laboratory accreditation program of the Geosynthetic Accreditation Institute (GAI) or the American Association for Laboratory Accreditation (A2LA).

960-3.1.2 Component and System Laboratory:

Test individual components and the PT system as a whole witnessed by and/or in a certified independent laboratory audited by the AASHTO Materials Reference Laboratory (AMRL).

960-3.2 Testing Requirements:

960-3.2.1 System Pressure Test:

~~(a)~~1. For each Family of PT systems, assemble system as detailed on the system drawings and perform pressure tests defined in this Article. A family of PT systems is a group of PT tendon/bar assemblies of various sizes using common anchorage devices and design.

~~(b)~~2. Perform tests on the largest assembly and the smallest assembly for each family of PT systems.

~~(c)~~3. Include in system test at least one of each component required to install a tendon from anchorage cap to anchorage cap.

~~(d)~~4. Include plastic duct to steel pipe connections and segment duct couplers, if applicable.

960-3.2.1.1 ~~Grout~~ Filler Containment Assembly Pressure Test:

~~(a)~~1. Assemble anchorage and anchorage cap with all required ~~grouting~~ filler injection attachments (e.g., grout tube, valves, plugs, etc.).

~~(b)~~2. Seal opening in anchorage where duct connects.

~~(c)~~3. Condition assembly by maintaining a pressure of 150 psi in system for three hours.

~~(d)~~4. After conditioning, assembly must sustain 150 psi internal pressure for five minutes with no more than 15 psi, or 10%, reduction in pressure.

~~(e)~~5. ~~Grout~~ Filler Containment Assembly Pressure Test requirement will be considered satisfied for systems using same anchorages, anchorage caps, and ~~grouting~~ filler injection attachments as a previously approved system as long as appropriate documentation from the previous submittal and written certification is provided by system Supplier stating that identical components are used in both assemblies.

960-3.2.1.2 External ~~(Smooth)~~ Duct Systems:

System testing for external ~~(smooth)~~ duct assemblies requires two additional tests beyond the ~~Grout~~ Filler Containment Assembly Pressure Test requirements:

~~(a)~~1. Anchorage and its connection to duct/pipe assembly must be tested in accordance with and satisfy requirements for the Internal ~~(Corrugated)~~ Duct Systems, where duct/pipe assembly consists of all components internal to concrete. Test assembly at 1.5 psi.

~~(b)~~2. Duct/pipe assembly consisting of all external duct connections (e.g., welded duct splices, duct-to-pipe connections, etc.) and ~~grout~~ vent must meet the following:

~~(1)~~a. Use 15 feet of pipe length for test pipe assembly.

~~(2)~~b. Condition assembly by maintaining a pressure of 150 psi in system for three hours.

~~(3)~~c. After conditioning, assembly must sustain 150 psi internal pressure for five minutes with no more than 15 psi, or 10%, reduction in pressure.

960-3.2.1.3 Internal ~~(Corrugated)~~ Duct Systems:

~~(a)~~1. Perform system test of assembly for compliance with 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".

~~(b)~~2. For bar systems, modify system test length to 15 feet.

~~(c)~~3. For systems being tested for use in precast segmental construction, modify this test to include one duct coupler or "O"-ring assembly intended for use at segment joint:

~~(1)~~a. Test duct coupler for proper function by casting it into a two part concrete test block using match cast techniques. Use blocks that are at least 12 inches x 12 inches x 12 inches.

~~(2)~~b. After concrete has hardened, pull blocks apart and clean surface of any bond breaker materials.

~~(3)~~c. Using an external apparatus, clamp blocks together and maintain 40 psi pressure on block cross-section during pressure test. Do not apply epoxy compound between blocks.

~~(4)~~d. Pressurize duct within test block to 5 psi and lock off outside air source.

~~(5)~~e. Assembly must sustain a 5 psi internal pressure for five minutes with no more than a 0.5 psi, or 10%, reduction in pressure.

~~(d)~~4. Remove clamping device, separate duct coupler blocks from duct system, and place a 1/16 inch layer of epoxy compound (Type B per Section 926) on face of both blocks, clamp blocks together, and maintain a pressure of 40 psi on block cross-section for 24 hours. Upon removal of clamping force, demolish blocks. Duct coupler and attached ducts should be intact and free of epoxy compound and properly attached without crushing, tearing, or other signs of failure.

960-3.2.1.4 Systems for use with Vacuum-Assisted Flexible Filler Injection: In addition to the testing specified above, all PT systems that will be used in conjunction with vacuum-assisted flexible filler injection must meet the following requirements:

1. Prepare a system assembly consisting of at least one of the each component required to install a tendon from anchorage cap to anchorage cap using 15 feet of duct.

2. Condition the assembly by maintaining a 90% vacuum in it for 1 hour.

3. After conditioning, the assembly must sustain a 90% vacuum for 5 minutes with no more than a 10% loss of vacuum. Calculate the percent vacuum in the assembly as follows:

100 x Vacuum Gauge Pressure / 29.92 inches Hg

or
100 x Vacuum Gauge Pressure / 14.7 psi

960-3.2.2 Minimum Bending Radius:

Establish bending radius for duct through testing. Test consists 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". Use identical test apparatus as that used for wear test with same clamping force as a function of number of strands in a duct.

~~(a)~~1. Modify procedure as follows: After the specimen has reached its final position, remove the specimen and confirm that the residual thickness is adequate. With confirmation that the residual thickness is acceptable, immediately (within 30 minutes) reapply the original clamping force for 14 days.

~~(b)~~2. Upon completion of test, remove duct and measure wall thickness along strand path. Wall thickness must not be less than 0.03 inches for duct up to 3.35 inches diameter and not less than 0.04 inches for duct greater than 3.35 inches diameter.

960-3.2.3 Additional Material Tests:

Ensure internal duct system components and accessories meet requirements of Chapter 4,~~:~~ Articles 4.1.1 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 below:

~~(a)~~1. Conduct lateral load resistance test (fib 4.1.4) without use of a duct stiffener plate using a 150 pound load for all sizes.

~~(b)~~2. Wear resistance of duct (fib 4.1.7) as modified above.

~~(c)~~3. Bond length test (fib 4.1.8) must achieve 40% of GUTS in a maximum length of 16 duct diameters.

4. For smooth duct injected with flexible filler (e.g. microcrystalline wax), fib 4.1.8 does not apply.

960-3.3 Required Sizes:

Develop and test PT systems for both internal ~~(corrugated duct)~~ and external ~~(smooth duct)~~ applications for the following:

~~(a)~~1. Department standard tendon sizes for designing and detailing consist of 0.6 inch diameter strand in anchorages containing 4, 7, 12, 15, 19, 27, and 31 strands.

~~(b)~~2. Standard bar sizes range from 5/8 inches to 2-1/2 inches diameter.

~~(c)~~3. Systems using alternate anchorage sizes and/or strands utilizing 1/2 inch strand and providing equivalent force to these standard sizes may be submitted for approval.

960-3.4 System Modifications:

Contact the SDO for direction before attempting to change pre-approved PT system materials or components. Repeat all appropriate material, component, and entire system tests if any component of a pre-approved PT system is modified or replaced, excluding local zone reinforcement. Submit an updated application to the SDO containing test reports and revised system drawings for proposed modified systems.

960-3.5 Component Samples:

Furnish all required material samples to laborator~~y~~ies for testing and to the Department as requested, at no cost to the Department.

960-3.6 Calculations, Drawings, and Certification:

Show fully detailed drawings of all component configurations, connections, anchor~~age~~s, inlets, outlets, drains, high point outlet inspection details, anchor~~age~~ inspection details, permanent anchor~~age~~ caps and application limits of the PT system for approval and posting on the SDO's website for Approved Post-Tensioning Systems. Submit details of typical local zone reinforcement in system drawings signed and sealed by a Specialty Engineer. Indicate that all PT system components are stamped with

~~(~~1~~)~~. manufacturer's name~~,~~

~~(~~2~~)~~. trademark model number~~, and~~

~~(~~3~~)~~. size corresponding to catalog description on PT system drawings.

Provide an application package cover letter signed by an officer of the PT system vendor certifying that the submitted PT system, as a whole and all of its individual components, meet or exceed all material and component/system requirements of this Section, as demonstrated by the submittal. Indicate in this certification that all testing required by this Section was performed by a certified independent laboratory (or laboratories), as defined in 960-3.1, and that all tests were performed to applicable ASTM and fib Specifications. Provide proof of current laboratory accreditation specifically indicating applicable accreditation categories related to PT systems. Provide all material and component certifications required throughout this Section.