Florida Department of Transportation

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August 8, 2016

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section **960**
Proposed Specification: **9600202 Post-Tensioning Components.**

Dear Mr. Nguyen:

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

The changes are proposed by Charles Boyd of the State Structures Design Office to adopt the new fib Bulletin 75 criteria for corrugated post tensioning ducts and make other various changes related to flexible filler injection.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to dan.hurtado@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Signature on file

Dan Hurtado, P.E.
State Specifications Engineer

DH/ot
Attachment
cc: Florida Transportation Builders' Assoc.
State Construction Engineer

POST-TENSIONING COMPONENTS.
(REV ~~5-276-38-5~~-16)

SUBARTICLE 960-2.1(5) is deleted and the following substituted:

5. Test anchorages in accordance with AASHTO LRFD Bridge Construction Specifications, or the Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures (ETAG-013, June 2002 edition) with the exception that the design concrete strength used in the testing will be 6,500 psi. For anchorages that will be used for tendons with flexible filler, test anchorages in accordance with ETAG-013 Section 6.1.2-I~~, with the exception that the design concrete strength used in the testing will be 6,500 psi~~.

SUBARTICLE 960-2.2.1.1 is deleted and the following substituted:

960-2.2.1.1 Corrugated Plastic Duct:

1. PT systems with duct injected with grout shall use corrugated polypropylene plastic material except where steel pipe is required.

2. Furnish ducts with minimum wall thickness as follows:

Table 2.2.1.1-1: Corrugated Plastic Duct Minimum Wall Thicknesses

Duct Shape	Duct Diameter	Duct *Wall* 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

SUBARTICLE 960-2.2.1.3 is deleted and the following substituted:

960-2.2.1.3 Steel Pipe:

~~Where specified in the Contract Documents, s~~Steel pipes shall be *ASTM A53, Type E, Grade B,* Schedule 40 and galvanized in accordance with Section 962.

SUBARTICLE 960-2.2.1.5 is deleted and the following substituted:

960-2.2.1.5 Connections, Fittings, and Tolerance:

1. Devices or methods for all duct connections (e.g., splices, joints, couplers, connection to anchorages), shall produce smooth interior alignment with no lips or kinks.

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 that are external to the concrete with a minimum pressure rating of ~~100~~ *150* 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.

8. Use heat welding techniques, electrofusion duct couplers, or elastomer sleeves and stainless steel band clamps to make connections between sections of smooth plastic duct.

9. Use elastomer sleeves and stainless steel band clamps to make connections between smooth plastic duct and steel pipe.

10. Use welding or elastomer sleeves and stainless steel band clamps to make connections between sections of steel pipe that are external to the concrete.

11. Use welding, elastomer 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.

12. Use elastomer sleeves with a minimum wall thickness of 3/8 inches and reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide stainless steel power seated band and clamps on each end of the elastomer sleeves to secure the sleeves to plastic ducts or steel pipes. Seat the bands with a 120 pound force prior to clamping them in place.

SUBARTICLE 2.4.6 is deleted and the following substituted:

960-2.4.6 Elastomer Sleeves:

Conform to all of the following:

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

2. *Manufactured using* ~~Constructed of~~ an elastic polymeric material that is compatible with *concrete,* the ~~in-situ conditions and~~ PT system components *to which the sleeves will be attached, and* ~~including~~ the filler material and filler material installation process. *Identify the applicable ASTM specification~~(~~s~~)~~ that the sleeve material complies with.*

ARTICLE 960-3 is deleted and the following substituted:

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 submit 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 *Component and* System ~~Pressure~~ Test*s*:

~~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.~~

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

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

~~4. Include plastic duct to steel pipe connections and segment duct couplers, if applicable.~~*Corrugated duct, smooth duct and all associated components that are used for both internal and external PT systems, e.g. couplers, anchorages, inlets, outlets, valves, plugs, etc., shall meet the requirements of fib Technical Report Bulletin 75 titled, "Polymer-Duct Systems for Internal Bonded Post-Tensioning", Performance Level 2 (PL2), with modifications as shown in Table 3.2.1-1.*

Table 3.2.1-1 Required Component and System Tests

Reference to fib Bulletin 75			*Required Tests for each PT System Type*[1]		
Procedures	*Appendix*	*Test Description*	*Internal PT System with Grout*	*Internal PT System with Flexible Filler*	*External PT System with Flexible*

					Filler
Component Assessment	A.1	Dimensional requirement	Yes	~~Yes~~No	~~Yes~~No
	A.2	Stiffness of duct	Yes[2]	~~Yes[2]~~No	~~Yes[2]~~No
	A.3	Longitudinal load resistance	Yes	Yes	Yes
	A.4	Lateral load resistance	Yes	~~Yes~~No	No
	A.5	Flexibility of duct system	Yes	Yes	No
	A.6	Leak tightness of duct system	Yes	Yes	No
	A.7	Concrete pressure on duct	Yes[3]	~~Yes[3]~~No	No
	A.8	Wear resistance of duct	Yes	No	No
	A.9	Wear resistance of duct under sustained load	Yes	No	No
	A.10	Bond behavior of duct	Yes	No	No
	A.11	Precast segmental duct coupler system	Yes[4]	Yes[4]	No
	A.12	Fracture resistance of duct	No	No	No
System Assessment	B.1	Leak tightness of anchorage-duct assembly	Yes[5]	Yes[5]	Yes[5]
	B.2	EIT performance of duct system	No	No	No
	B.3	EIT performance of anchorage-duct assembly	No	No	No
	B.4	Full scale duct system assembly	Yes[5][6]	Yes[5][6]	Yes[5][6]
	B.5	Leak tightness of assembled duct system	Yes[5][6]	Yes([5][6]	No

1. Yes = Test is required; No = Test is not required.
2. Do not preload strand into duct prior to testing.
3. Identify duct as meeting Performance Class I or II criteria.
4. Use an epoxy meeting the requirements of Section 926, Type B.
5. Perform tests on the largest assembly and the smallest assembly for each family of PT systems. A family of PT systems is defined a group of PT strand/bar assemblies of various sizes using common anchorage devices and design.
6. For each test, use a PT system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap. For bar tendon systems, use between 15 and 50 feet of duct with a straight profile.

960-3.2.~~1.1~~2 Filler Containment Assembly Pressure Test:

In addition to the other testing specified in this Section, test all filler containment assemblies, i.e., anchorages, anchorage caps, inlets, outlets, valves, plugs, etc., as follows:

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

2. Seal *the* opening in *the* anchorage where *the* duct*/trumpet* connects.

3. Condition *the* assembly by maintaining a pressure of 150 psi in *the* system for three hours.

4. After conditioning, *lock off the air supply to the assembly.*

5. After lock off, the assembly must sustain 150 psi internal pressure for five minutes with no more than 15 psi, or 10%, reduction in pressure.

This test may be combined ~~wiith~~with the External Duct Systems Pressure Test for external PT systems.

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

960-3.2.~~1.2~~*3* External *PT* ~~Duct~~ Systems *Pressure Test*:

In addition to the other testing specified in this Section, test all external PT systems as follows:

1. Prepare a system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap using between 15 and 50 feet of duct with a straight profile.

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

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

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

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

~~b~~*2*. Condition *the* assembly by maintaining a pressure of ~~150~~ *100* psi in *the* system for three hours.

~~c~~*3*. After conditioning, *lock off the air supply to the assembly.*

4. After lock off, the assembly must sustain ~~150~~ *100* psi internal pressure for five minutes with no more than ~~15~~ *10* psi~~, or 10%,~~ reduction in pressure.

~~**960-3.2.1.3 Internal Duct Systems:**~~

~~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".~~

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

~~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:~~

~~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.~~

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

~~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.~~

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

~~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.~~

~~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 *Vacuum Test for Internal and External PT* Systems ~~for use~~ with ~~Vacuum-Assisted~~ Flexible Filler ~~Injection~~: In addition to the *other* testing specified in this Section, *test internal PT systems with flexible filler and* all *external* PT ~~systems that will be used in conjunction with vacuum-assisted flexible filler injection must meet the following requirements~~*as follows*:

1. Prepare a system assembly consisting of at least one of ~~the~~ each component *and connection type* required to install a tendon from anchorage cap to anchorage cap using *between* 15 *and 50* feet of duct.

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

3. After conditioning, *lock off the air supply to the assembly.*

4. After lock off, the assembly must sustain a 90% vacuum for 5 minutes with no more than a 10% loss of vacuum.

~~**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.~~

~~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.~~

~~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:~~

~~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.~~

~~2. Wear resistance of duct (fib 4.1.7) as modified in this Section.~~

~~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, fib 4.1.1 through 4.1.8 does not apply.~~

960-3.3 *Standard Tendon*~~Required~~ Sizes:

Develop and test PT systems for both internal and external applications *that can accommodate*~~for~~ the following *Department standard tendon sizes that are used for designing and detailing*:

1. ~~Department s~~*S*tandard *strand* tendon sizes*:* ~~for designing and detailing consist of 0.6 inch diameter strand in anchorages containing~~ 4, 7, 12, 15, 19, 27, and 31 strand *tendon*s, *each using 0.6 inch diameter strand*. *Systems using alternate anchorage sizes* ~~*and/*~~*or 1/2 inch diameter strand that provide equivalent force to these standard sizes may be submitted for approval.*

2. Standard bar *tendon diameters:* ~~sizes range from 5/8 inches to 2-1/2 inches~~ *5/8, 3/4, 1, 1-1/4, 1-3/8, 1-3/4, 2-1/2 and 3 inch* diameter *bars*.

~~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 laboratories 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, anchorages, inlets, outlets, drains, high point outlet inspection details, anchorage inspection details, permanent anchorage caps, ~~and~~ application limits of the PT system*, and installation procedures of components* 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 the following:

1. Manufacturer's name
2. Trademark model number
3. Size corresponding to catalog description on PT system drawings.

Submit 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. Submit proof of current laboratory accreditation specifically indicating applicable accreditation categories related to PT systems. Submit all material and component certifications required throughout this Section.

POST-TENSIONING COMPONENTS.
(REV 8-5-16)

SUBARTICLE 960-2.1(5) is deleted and the following substituted:

5. Test anchorages in accordance with AASHTO LRFD Bridge Construction Specifications, or the Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures (ETAG-013, June 2002 edition) with the exception that the design concrete strength used in the testing will be 6,500 psi. For anchorages that will be used for tendons with flexible filler, test anchorages in accordance with ETAG-013 Section 6.1.2-I.

SUBARTICLE 960-2.2.1.1 is deleted and the following substituted:

960-2.2.1.1 Corrugated Plastic Duct:

1. PT systems with duct injected with grout shall use corrugated polypropylene plastic material except where steel pipe is required.

2. Furnish ducts with minimum wall thickness as follows:

Table 2.2.1.1-1: Corrugated Plastic Duct Minimum Wall Thicknesses

Duct Shape	Duct Diameter	Duct Wall 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

SUBARTICLE 960-2.2.1.3 is deleted and the following substituted:

960-2.2.1.3 Steel Pipe:

Steel pipes shall be ASTM A53, Type E, Grade B, Schedule 40 and galvanized in accordance with Section 962.

SUBARTICLE 960-2.2.1.5 is deleted and the following substituted:

960-2.2.1.5 Connections, Fittings, and Tolerance:

1. Devices or methods for all duct connections (e.g., splices, joints, couplers, connection to anchorages), shall produce smooth interior alignment with no lips or kinks.

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 that are external to the concrete with a minimum pressure rating of 150 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.

8. Use heat welding techniques, electrofusion duct couplers, or elastomer sleeves and stainless steel band clamps to make connections between sections of smooth plastic duct.

9. Use elastomer sleeves and stainless steel band clamps to make connections between smooth plastic duct and steel pipe.

10. Use welding or elastomer sleeves and stainless steel band clamps to make connections between sections of steel pipe that are external to the concrete.

11. Use welding, elastomer 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.

12. Use elastomer sleeves with a minimum wall thickness of 3/8 inches and reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide stainless steel power seated band and clamps on each end of the elastomer sleeves to secure the sleeves to plastic ducts or steel pipes. Seat the bands with a 120 pound force prior to clamping them in place.

SUBARTICLE 2.4.6 is deleted and the following substituted:

960-2.4.6 Elastomer Sleeves:

Conform to all of the following:

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

2. Manufactured using an elastic polymeric material that is compatible with concrete, the PT system components to which the sleeves will be attached, and the filler material and filler material installation process. Identify the applicable ASTM specifications that the sleeve material complies with.

ARTICLE 960-3 is deleted and the following substituted:

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 submit 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 Component and System Tests:

Corrugated duct, smooth duct and all associated components that are used for both internal and external PT systems, e.g. couplers, anchorages, inlets, outlets, valves, plugs, etc., shall meet the requirements of fib Technical Report Bulletin 75 titled, “Polymer-Duct Systems for Internal Bonded Post-Tensioning”, Performance Level 2 (PL2), with modifications as shown in Table 3.2.1-1.

Table 3.2.1-1 Required Component and System Tests

Reference to fib Bulletin 75			Required Tests for each PT System Type(1)		
Procedures	Appendix	Test Description	Internal PT System with Grout	Internal PT System with Flexible Filler	External PT System with Flexible Filler
Component Assessment	A.1	Dimensional requirement	Yes	No	No
	A.2	Stiffness of duct	Yes(2)	No	No
	A.3	Longitudinal load resistance	Yes	Yes	Yes
	A.4	Lateral load resistance	Yes	No	No
	A.5	Flexibility of duct system	Yes	Yes	No
	A.6	Leak tightness of duct system	Yes	Yes	No
	A.7	Concrete pressure on duct	Yes(3)	No	No
	A.8	Wear resistance of duct	Yes	No	No
	A.9	Wear resistance of duct under sustained load	Yes	No	No

	A.10	Bond behavior of duct	Yes	No	No
	A.11	Precast segmental duct coupler system	Yes(4)	Yes(4)	No
	A.12	Fracture resistance of duct	No	No	No
System Assessment	B.1	Leak tightness of anchorage-duct assembly	Yes(5)	Yes(5)	Yes(5)
	B.2	EIT performance of duct system	No	No	No
	B.3	EIT performance of anchorage-duct assembly	No	No	No
	B.4	Full scale duct system assembly	Yes(5)(6)	Yes(5)(6)	Yes(5)(6)
	B.5	Leak tightness of assembled duct system	Yes(5)(6)	Yes(5)(6)	No

1. Yes = Test is required; No = Test is not required.
2. Do not preload strand into duct prior to testing.
3. Identify duct as meeting Performance Class I or II criteria.
4. Use an epoxy meeting the requirements of Section 926, Type B.
5. Perform tests on the largest assembly and the smallest assembly for each family of PT systems. A family of PT systems is defined a group of PT strand/bar assemblies of various sizes using common anchorage devices and design.
6. For each test, use a PT system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap. For bar tendon systems, use between 15 and 50 feet of duct with a straight profile.

960-3.2.2 Filler Containment Assembly Pressure Test:

In addition to the other testing specified in this Section, test all filler containment assemblies, i.e., anchorages, anchorage caps, inlets, outlets, valves, plugs, etc., as follows:

1. Assemble the anchorage and anchorage cap with all required filler injection attachments.
2. Seal the opening in the anchorage where the duct/trumpet connects.
3. Condition the assembly by maintaining a pressure of 150 psi in the system for three hours.
4. After conditioning, lock off the air supply to the assembly.
5. After lock off, the assembly must sustain 150 psi internal pressure for five minutes with no more than 15 psi, or 10%, reduction in pressure.

This test may be combined with the External Duct Systems Pressure Test for external PT systems.

960-3.2.3 External PT Systems Pressure Test:

In addition to the other testing specified in this Section, test all external PT systems as follows:

1. Prepare a system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap using between 15 and 50 feet of duct with a straight profile.
2. Condition the assembly by maintaining a pressure of 100 psi in the system for three hours.
3. After conditioning, lock off the air supply to the assembly.
4. After lock off, the assembly must sustain 100 psi internal pressure for five minutes with no more than 10 psi reduction in pressure.

960-3.2.4 Vacuum Test for Internal and External PT Systems with Flexible Filler: In addition to the other testing specified in this Section, test internal PT systems with flexible filler and all external PT as follows:

1. Prepare a system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap using between 15 and 50 feet of duct.
2. Condition the assembly by maintaining a 90% vacuum in it for 1 hour.
3. After conditioning, lock off the air supply to the assembly.
4. After lock off, the assembly must sustain a 90% vacuum for 5 minutes with no more than a 10% loss of vacuum.

960-3.3 Standard Tendon Sizes:

Develop and test PT systems for both internal and external applications that can accommodate the following Department standard tendon sizes that are used for designing and detailing:

1. Standard strand tendon sizes: 4, 7, 12, 15, 19, 27, and 31 strand tendons, each using 0.6 inch diameter strand. Systems using alternate anchorage sizes or 1/2 inch diameter strand that provide equivalent force to these standard sizes may be submitted for approval.
2. Standard bar tendon diameters: 5/8, 3/4, 1, 1-1/4, 1-3/8, 1-3/4, 2-1/2 and 3 inch diameter bars.

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 laboratories 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, anchorages, inlets, outlets, drains, high point outlet inspection details, anchorage inspection details, permanent anchorage caps, application limits of the PT system, and installation procedures of components 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 the following:

1. Manufacturer's name
2. Trademark model number
3. Size corresponding to catalog description on PT system drawings.

Submit 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. Submit proof of current

laboratory accreditation specifically indicating applicable accreditation categories related to PT systems. Submit all material and component certifications required throughout this Section.