ORIGINATION FORM
Proposed Revisions to the Specifications
(Please provide all information - incomplete forms will be returned)

Date: 7/7/22

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Office: Structures Design Office

Specification Section: 462

Article/Subarticle: Multiple

Associated Section(s) Revisions: 960-2.2.2

Will the proposed revision require changes to:

Publication	Yes	No	Office Staff Contacted
Standard Plans Index	◉	○	Rick Jenkins/Joshua Turley
Traffic Engineering Manual	◉	○	Javier Ponce
FDOT Design Manual	◉	○	Gevin McDaniel
Construction Project Administration Manual	◉	○	David Wagner
Basis of Estimate/Pay Items	◉	○	Ryan Gray
Structures Design Guidelines	◉	○	Ben Goldsberry
Approved Product List	◉	○	Karen Byram
Materials Manual	◉	○	Tim Counts
Maintenance Specs	◉	○	Deanna Hutchison

Will this revision necessitate any of the following:

Design Bulletin ☐ **Construction Bulletin** ☐ **Estimates Bulletin** ☐ **Materials Bulletin** ☐

Have all references to internal and external publications in this Section been verified for accuracy? (Select)

Synopsis: Summarize the changes:

These changes address the presence of water and moisture within ducts for tendons with flexible filler. Addressed other miscellaneous editorial updates.

Justification: Why does the existing language need to be changed?

These changes are needed to address recent issues with water discovered inside ducts of tendons with flexible filler, which resulted in tendon failure due to corrosion.

Do the changes affect either of the following types of specifications (Hover over type to go to site.):

Special Provisions ☐ **Developmental Specifications** ☐

List Specifications Affected: (ex. SP3270301, Dev330TL, Dev334TL etc.)

Contact the State Specifications Office for assistance completing this form.
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POST-TENSIONING
(REV 7-11-22)

ARTICLE 462-1 is deleted and the following substituted:

462-1 Description.

1. Furnish, test, transport, store, handle, and install all components of Post-Tensioning (PT) systems, in accordance with the requirements of this Section and the component manufacturer's recommendations. Constituent components of PT systems include, but are not limited to, anchorage assemblies, filler containment assemblies, filler material, and related steel reinforcement. Use the most stringent requirements, as determined by the Engineer, of those specified in this Section or the component manufacturer's recommendations for protecting components from damage due to environmental exposure, improper handling, or improper installation.

2. With the exception of mild reinforcing and prestressing steel, furnish all PT system components from a single supplier (vendor).

3. Submit PT system shop drawings in accordance with Section 5. Perform PT system testing in accordance with Section 960. Include in the PT system testing all possible combinations of components to be incorporated into the structure.

4. Use only PT systems meeting the requirements of Section 960 and approved by the Engineer in accordance with Section 5.

a. Use only PT systems of appropriate type and size required to construct tendons shown in the Contract Documents.

b. Use only the exact manufacturer and/or model of major components, as defined in 960-2, that were used in system testing and as listed on the approved PT system shop drawings.

c. With the exception of local zone reinforcement, do not substitute, modify, or delete any major components, as defined in 960-2, of a PT system approved by the Engineer for use on the project.

5. Provide a mockup test in accordance with this Section. PT system acceptance testing may be performed concurrent with mockup testing if performed prior to installation of any PT system hardware.

6. Install the PT tendon (e.g., strands, wires, or bars) in ducts. Stress the PT tendon to a predetermined load and anchor ends directly against hardened concrete. After anchoring the PT tendon, install permanent anchorage caps, verify that no water is present within the duct, inject ducts with filler to completely fill voids, and install protection at anchorages.

7. Submit all required documents in accordance with this Section and Section 5 to the Engineer for review and written approval.

8. Arches, ~~C~~cable ~~stays~~supported and extradosed bridges are not covered by this Specification.

9. Install duct filler. Provide fully filled duct and anchorage assemblies free from leaks, blockages, and voids. Submit test data to the Engineer to verify that the work meets the requirements of this Section. Perform filler injection operations in accordance with 462-7.4.

SUBARTICLE 462-2.2.1 is deleted and the following substituted:

462-2.2 Steel Reinforcing:

462-2.2.1 Mild Steel:

1. Provide reinforcing steel per Section 931.

2. Final design and details of local zone reinforcement are ~~project~~system specific and are the responsibility of PT system supplier (vendor). Design ~~project~~system specific local zone reinforcement for the number of strands or wires a particular PT system can accommodate at maximum allowable strand or wire force; do not design project specific local zone reinforcement for a reduced system capacity.

3. Submit signed and sealed project specific local zone reinforcement details to the Engineer for review and written approval.

SUBARTICLE 462-7.2.1 is deleted and the following substituted:

462-7.2.1 Ducts:

1. Construct tendon ducts using the minimum number of splices as practical.

2. Accurately position and align ducts at locations shown in the Contract Documents, or according to approved shop or working drawings, or as approved in writing by the Engineer.

3. Securely fasten all internal ducts at regular intervals not exceeding 30 inches for steel pipes, 24 inches for round plastic ducts, and 12 inches for flat ducts to prevent movement, displacement, or damage from concrete placement and consolidation operations.

4. Show method and spacing of duct supports on appropriate shop drawings.

5. Ensure external tendon ducts are straight between connections to internal ducts at anchorages, diaphragms, and deviation saddles and are supported at intermediate locations according to the Contract Documents including approved shop drawings.

6. Ensure all alignments, including curves and straight portions, are smooth and continuous with no lips, kinks, or dents. This also applies to curves in pre-bent steel pipe.

7. Check and repair all ducts in accordance with 462-7.5 as necessary before placing any concrete.

8. Ensure ducts at end connections to anchorages, splices, inlets, outlets, drains, and all other duct openings are sealed at all times after installing ducts and until tendon installation is complete. Briefly open low point drains just prior to tendon installation and again just prior to filler injection to allow for drainage of any water that may be present within the duct.

9. Close all ports except the inlet and outlet ports at the anchorage caps. Just prior to tendon installation, blow oil-free dry compressed air through one of the anchorage cap ports to remove standing water, moisture or debris. Continue to blow oil-free dry compressed air until the humidity of air inside the duct is less than 40% measured at the downstream end of blowing.

10. Provide an absolute seal of anchorage and duct termination locations per the ~~pre-~~approved system drawings.

~~10~~11. Use of tape, caulking, epoxy or other sealants is not permitted to make connections or sealing for any reason.

~~11~~12. Use heat welding techniques, in accordance with duct manufacturer's instructions, to make splices between sections of smooth plastic duct or make connection with electrofusion duct coupler as shown on the approved PT system shop drawings.

~~12~~13. When connecting steel pipe to plastic pipe with a boot, use a 3/8 inches wide power seated band and clamps in accordance with 960-2.2 on each end of a duct boot to seal against filler leakage. Install band per manufacturer's instructions.

~~13~~14. Ducts for prestressing used exclusively for temporary erection where PT will be removed from structure are not required to be coupled across segment joints.

SUBARTICLE 462-7.2.1.1 is deleted and the following substituted:

462-7.2.1.1 Installation Tolerances:

1. Ensure final position of PT ducts is within the tolerances in the following table:

Table 462-1
Duct Installation Tolerances

Type	Vertical Position (inches)	Horizontal Position (inches)
Horizontal tendons in slabs or in slab regions of larger members	±1/4	±1/2
Longitudinal draped superstructure tendons in webs: Tendon over supports or in middle third of span	±1/4	±1/4
Tendon in middle half of web depth	±1/2	±1/4
Longitudinal, generally horizontal, superstructure tendons usually in top or bottom of member	±1/4	±1/4
Horizontal tendons in substructures and foundations	±1/2	±1/2
Vertical tendons in web	Longitudinal Position ±1	Transverse Position ±1/4
Vertical tendons in pier shafts	±1/2	±1/4
All other cases	±1/4	±1/4

2. Ensure entrance and exit angles of tendon paths at anchorages, duct joints, and/or at faces of concrete are within plus or minus 3 degrees of desired angle measured in any direction.

3. Accomplish any deviations in alignment with smooth unkinked transitions.

4. Locate anchorages within plus or minus 1/4 inches of desired position laterally and plus or minus 1 inch along tendon except that minimum cover requirements must be maintained.

5. Position local zone anchorage confinement reinforcement in the form of spirals, multiple U-shaped bars, or links centered around duct and anchorage (±1/4 inch tolerance) and starting within 1/2 inch~~es~~ of the back of the main anchorage plate.

6. If conflicts exist between reinforcement and a PT duct/anchorage and other non-local zone reinforcement, the position of duct prevails. Adjust the non-local zone reinforcement with the Engineer's written approval.

SUBARTICLE 462-7.2.3 is deleted and the following substituted:

462-7.2.3 Inlets, Outlets, Drains and Ports:

1. Place filler inlets, outlets, drains and ports at locations shown in the Contract Documents including approved shop drawings.

2. Equip all filler inlets, outlets, drains and ports with approved positive shut-off devices (e.g., valves).

3. At a minimum, place filler inlets, outlets or ports in the following positions and those shown in Standard Plans, Index 462-001:

a. Top of tendon anchorage;

b. Top and bottom of anchorage cap;

c. At high points of duct profile when vertical distance between highest and lowest point is more than 2 feet;

d. At major change in duct cross section; and,

e. At other locations required by the Engineer.

4. For all tendons other than grouted top slab transverse tendons in box girders, place drains at the geometric low points of all duct profiles, or as close as is practical to the geometric low points of all duct profiles, except where an inlet, outlet or anchorage that can serve as a drain is located at a low point. Locate drains, and inlets and outlets serving as drains, at the bottom of the duct cross section. Do not locate drains within the limits of diabolos for external tendons.

5. Extend filler and drain tubes a sufficient distance out of concrete member to allow for proper closing of valves.

6. Direct inlets, outlets, drains and ports exiting on vertical or predominantly vertical surfaces of box and I-girders toward the inside face of exterior I-girders or toward the interior of box girders.

SUBARTICLE 462-7.2.4 is deleted and the following substituted:

462-7.2.4 Tendons:

1. Prestressing steel must be completely dry prior to installation within the duct.

2. Do not exceed 14 calendar days between first installation of prestressing steel within duct and completion of the stressing and filler injection operation for PT bars located in superstructure and all strands and wires regardless of location. With written approval of the Engineer, the number of calendar days can be extended to a maximum of 30 by continuously maintaining the air humidity within the duct below 40%. The use of temporary corrosion inhibitor powder is not permitted as a method to increase the allowed number of calendar days.

23. Do not exceed 21 calendar days between the first installation of prestressing steel within duct and completion of the stressing and filler injection operations for PT bars located in substructure. With written approval of the Engineer, the number of calendar days can be extended to a maximum of 60 by continuously maintaining the air humidity within the duct below 40%. The use of temporary corrosion inhibitor powder is not permitted as a method to increase the allowed number of calendar days.

34. Any light surface corrosion forming during the period of time described in (1) or (2) will not be cause for rejection of prestressing steel.

45. Failure to inject filler into duct within the number of calendar days specified, will result in stoppage of work, except when waived by the Engineer in writing.

56. Flushing of filler is not permitted without written approval of the Engineer and is only permitted as defined in this Article.

67. For grouted operations, vacuum injection is required to repair all voids and blockages as subject to provisions of 462-8.3.2. For flexible filler operations, use the repair procedure described in the approved Wax Injection Operations Plan.

78. For tendon ducts subjected to contamination with chlorides (e.g., uncapped ducts that have been subjected to salt spray), flush duct with potable water containing slack lime (i.e., calcium hydroxide) or quicklime (i.e., calcium oxide) in the amount of 0.17 pounds per gallon.

a. Test for presence of chlorides and oils in discharged water before placing tendon.

b. If chloride levels in flush water outflow exceed 300 ppm, continue to flush duct until chloride level in flush water outflow is below 250 ppm.

c. Dry duct interior by blowing oil-free compressed air, by vacuuming, or by other means deemed acceptable to the Engineer. Remove excess water trapped in duct corrugations. The Engineer may require use of a borescope or other visual inspection means, at no additional cost to the Department, to ensure duct interior is water free.

89. Push or pull strands and wires through ducts to make up a tendon using methods that will not snag on any lips or joints in ducts.

910. Round off end of strands and wires that are pushed or fit advancing end with smooth protective cap.

1011. Do not intentionally rotate strands or wires by any mechanical means during installation of PT strand into duct.

1112. For superstructure tendons, provide sufficient strand and wire length beyond dead end anchorages to allow for second end stressing as needed for reconciliation of jacking force versus measured elongation.

1213. Alternatively, tendons may be pulled through duct using a special steel wire sock or other device attached to advancing end. Strands may be brazed together for pulling as long as one foot of strand from the brazed end is removed by cutting after installation. Do not electric arc weld strand ends together for this purpose.

1314. Cut tendons in accordance with 462-7.3.2.7.

1415. Strand installation aids (i.e. wire/nylon ties around strand bundle, strand spacers, etc.) must be removed prior to stressing

1516. Do not install permanent tendons before completion of testing as required by this Section or the Contract Documents. The only two exceptions are:

a. Tendon to be tested by "Theoretical Elongation Verification" may be installed for test; and,

b. Transverse tendons may be pre-installed in precast segmental boxes prior to concrete casting such that they meet 462-8.3.1.

SUBARTICLE 462-7.3.2.1 is deleted and the following substituted:

462-7.3.2.1 Jacking Maximum Stress:

Maximum temporary stress (i.e., jacking stress) in PT steel must not exceed 80% and 75% of Guaranteed Ultimate Tensile Strength (GUTS) for PT strands and bars, respectively. The maximum temporary jacking stress must not exceed 50% of GUTS for PT bars that will be reused.

SUBARTICLE 462-7.3.2.4 is deleted and the following substituted:

462-7.3.2.4 Elongation:

1. Ensure forces being applied to tendon and resulting elongation of tendon can be measured at all times.

2. Measure elongations to nearest 1/16 inch.

3. For required tendon force, observed elongation must agree within 7% of theoretical elongation or entire operation must be halted, checked, and source of error determined and remedied to satisfaction of the Engineer before proceeding.

4. Do not overstress tendon to achieve theoretical elongation.

5. If~~n event that~~ agreement between observed and theoretical elongations at the required force falls outside acceptable tolerances, additional tests may be required, at the Engineer's ~~may, at his~~ discretion and without additional compensation to the Contractor, ~~require additional tests~~ for Tendon Modulus of Elasticity and/or In Place Wobble and Friction Test, or Lift-Off Test.

SUBARTICLE 462-7.4.1.1 is deleted and the following substituted:

462-7.4 Filler Injection Operations:

462-7.4.1 Grouting Operations: Conduct all grouting operations in the presence of the Engineer.

462-7.4.1.1 Grout Injection Operations Plan:

1. Submit a Grouting Operations Plan to the Engineer for approval at least six weeks in advance of any scheduled grouting operation.

2. Written approval of Grouting Operations Plan by the Engineer is required before any grouting of permanent structure takes place.

3. At minimum, Grouting Operations Plan will address and provide:

a. Names and proof of training for grouting crew and crew supervisor in conformance with this Specification;

b. Type, quantity, and brand of materials to be used in grouting, including all required certifications;

c. Type of equipment to be used, including capacity in relation to demand and working conditions, as well as, standby equipment and spare parts;

d. General grouting procedure;

e. Duct pressure test and repair procedures;

f. Procedures for checking the presence of water or moisture in the duct and measuring humidity of air within the duct;

~~f~~g. Method to be used to control rate of flow within ducts;

~~g~~h. Theoretical grout volume calculations;

~~h~~i. Mixing and pumping procedures in accordance with the manufacturer's recommendations;

i. Direction of grouting accounting for grade and/or slope of tendon;

j. Sequence of inlet and outlet pipes use;

k. Procedures for handling blockages;

l. Procedures for possible post grouting repair.

4. Conduct a joint meeting of the Contractor, grouting crew, and the Engineer before grouting operations begin. Discuss Grouting Operations Plan, required testing, corrective procedures, and any other relevant issues at the meeting.

5. Prior to production grouting, demonstrate to the Engineer's satisfaction successful grout injection by injecting full-scale mockups that are constructed with all associated PT system components using the mockup tendon profiles shown in the Plans and the proposed Grouting Operations Plan. Utilize smooth duct and associated couplers and fittings meeting the requirements of Section 960 for all mockups. Utilize smooth duct for the mockups which has an inside diameter required for a given mockup tendon size. If the mockup is also being used to perform PT system acceptance testing, use the duct type appropriate for the PT system location. Place the mockup tendons specified in the Plans inside the ducts to simulate the in-place PT tendons. Stress mockup tendons to the minimum values shown in the Plans by using jacks or other methods approved by the Engineer. Perform pressure tests on the mockups in accordance with 462-8.2.1 prior to grout injection. For the grout injection operations, utilize the same grout material and types and sizes of grout injection equipment that will be used on the project including but not limited to mixers, pumps, hoses, valves and pressure gauges. Inject grout into the mockups using the proposed Grouting Operations Plan. Allow the grout to harden a minimum of 24 hours after injection before inspecting the mockup. Inspect the mockup in accordance with the requirements of 462-8.3.2.1 and then carefully cut open the duct at all high points and other locations as directed by the Engineer to check for voids. Prepare a report documenting the findings and submit it to the Engineer. If voids are found, determine the cause and revise the proposed Grouting Operations Plan accordingly. If directed by the Engineer, construct additional mockups and repeat the grout injection operation using the revised Grouting Operations Plan as many times as are required until the results are acceptable.

SUBARTICLE 462-7.4.1.5.4 is deleted and the following substituted:

462-7.4.1.5.4 Grout Injection Operations:

1. Close all ports except the inlet and outlet ports at the anchorage caps. Just prior to grout injection, blow oil-free dry compressed air through one of the anchorage cap ports to remove standing water, moisture or debris. Continue to blow oil-free dry

compressed air until the humidity of air inside the duct is less than 40% measured at the downstream end of blowing.

2. Open all grout outlets before starting grouting operation.

~~2~~3. Inject grout into duct in accordance with approved Grouting Operations Plan.

~~3~~4. Pump grout at the lowest possible pressure practical.

~~4~~5. Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at grout inlet.

~~5~~6. Do not exceed a pumping pressure of 145 psi anywhere within the system. Do not exceed a pumping pressure of 75 psi at the grout inlet for flat ducts.

~~6~~7. Use grout pumping methods that ensure complete filling of ducts and complete encasement of steel.

~~7~~8. Grout must flow from first and subsequent outlets until any residual water or entrapped air has been removed prior to closing outlet.

~~8~~9. Pump grout through duct and continuously discharge it at anchorage and anchorage cap outlets until all free water and air are discharged and consistency of grout is equivalent to that of grout being pumped into inlet. Close anchorage outlet and discharge a minimum of two gallons of grout from anchorage cap into a clean receptacle. Close anchorage cap outlet.

~~9~~10. Elevate grout pressure to the equivalent realized pumping pressure while grouting the duct, seal inlet valve, and wait two minutes to determine if any leaks exist after all outlets have been bled and sealed. If leaks are present repair all identified leaks using methods pre-approved by the Engineer and repeat steps until no leaks are present. Bleed pressure to 5 psi and wait a minimum of ten minutes for any entrapped air to flow to high points if no leaks are present. Increase pumping pressure not to exceed actual realized pumping pressure of duct and discharge grout at each high point outlet to eliminate any entrapped air or water after specified ten minute period has expired. Complete process by locking a pressure of 30 psi into tendon duct.

~~10~~11. If actual grouting pressure exceeds maximum allowed, close inlet and pump grout at next outlet which has just been closed or is ready to be closed as long as a one-way flow is maintained. Do not pump grout into a succeeding outlet from which grout has not yet flowed. Fit outlet/inlet to be used for pumping with a positive shut-off valve as shown in the approved system drawings and pressure gauge if this procedure is used.

~~11~~12. Stop grouting operation if complete grouting of tendon cannot be achieved by the steps stated and in compliance with the approved Grouting Operations Plan. After waiting 48 hours, vacuum grout duct in accordance with this Section.

SUBARTICLE 462-7.4.1.5.6 is deleted and the following substituted:

462-7.4.1.5.6 Grouting Operations Report:

1. Submit grouting report signed by the grouting Contractor within five days of each grouting operation for review by the Engineer.

2. Record theoretical quantity of grout anticipated as compared to actual quantity of grout used to fill duct. Notify the Engineer immediately of shortages or overages.

3. Information to be noted in this report must include at a minimum, but not necessarily be limited to:

a. identification of tendon;
b. date grouted;
c. number of days from tendon installation to grouting;
d. type of grout;
e. injection end;
f. verification that water or moisture is not present within the duct;
g. duct humidity readings;
~~f~~h. pressure gauge readings at the pump and at the inlet;
~~g~~i. ratio of actual to theoretical grout quantity;
~~h~~j. number of grout bags mixed;
~~i~~k. total quantity of water used to mix grout;
~~j~~l. summary of any problems encountered; and,
~~k~~m. corrective action taken,
~~l~~n. description and results of the post grouting operations and inspection.

SUBARTICLE 462-7.4.2.1.1 is deleted and the following substituted:

462-7.4.2.1.1 Wax Injection Operations Plan:

1. Prepare a Wax Injection Operations Plan in cooperation with the PT system vendor and the PT wax manufacturer.
2. Submit the Wax Injection Operations Plan to the Engineer for approval at least six weeks in advance of any scheduled injection operation.
3. Written approval of the Wax Injection Operations Plan by the Engineer is required before any injection of permanent structure can begin.
4. At a minimum, the Wax Injection Operations Plan will address and provide the following:

a. .Names and qualifications for wax injection crew and crew supervisor in conformance with this Specification;
b. Type, quantity, and brand of materials to be used in wax injection including all required certifications;
c. Type of equipment to be used, including capacity in relation to demand and working conditions, as well as, standby equipment and spare parts;
d. Personal Protective Equipment (PPE);
e. Communication equipment to be used during injection;
d. Location and sequence of ducts to be injected;
e. Calculation of temporary elongation of tendons due to wax injection temperature;
f. Procedures for checking the presence of water or moisture in the duct and measuring humidity of air within the duct;

fg. General wax injection procedure for all duct geometries and types;

gh. Duct pressure test and repair procedures;

hi. Method to be used to control rate of flow within ducts and anchorage assembly;

ij. Theoretical wax volume calculations;

jk. Injection rate;

kl. Maximum injection pressure during injection and locking pressure;

lm. Vacuum (gauge) pressure requirements, vacuum tests and repair procedures;

mn. Heating, mixing and pumping procedures in accordance with the manufacturer's recommendations;

no. Direction of wax injection accounting for grade and/or slope of tendon;

op. Location of all high points and all low points accounting for grade and/or slope of tendon;

pq. Sequence of valve operations at PT system inlets and outlets, including minimum wax discharge quantities;

qr. Procedures for handling blockages;

rs. Procedure for sealing duct after wax injection;

st. Procedure for inspecting the PT system after wax injection, filling voids created by inspection procedures, and sealing duct after PT system inspection;

tu. Procedures for possible post injection repair;

uv. Method(s) and material(s) that will be used to protect concrete surfaces from wax spills, leaks, etc. during wax injection, post injection inspection and post injection repair;

vw. Safety and clean-up procedures;

5. Conduct a joint meeting of the Contractor, wax injection crew, and the Engineer before wax injection operations begin. Discuss Wax Injection Operations Plan, required testing, corrective procedures, and any other relevant issues at the meeting.

6. Prior to production wax injection, demonstrate to the Engineer's satisfaction successful wax injection by injecting full-scale mockups that are constructed with all associated PT system components using the mockup tendon profiles shown in the Plans and the proposed Wax Injection Operations Plan. Utilize smooth duct and associated couplers and fittings meeting the requirements of Section 960 for all mockups. Utilize smooth duct for the mockups which has an inside diameter required for a given mockup tendon size. If the mockup is also being used to perform PT system acceptance testing, use the duct type appropriate for the PT system location. Place the mockup tendons specified in the Plans inside the ducts to simulate the in-place PT tendons. Stress mockup tendons to the minimum values shown in the Plans by using jacks or other methods approved by the Engineer. Perform pressure tests on the mockups in accordance with 462-8.2.1 prior to wax injection. If vacuum assisted wax injection is required to be used, perform vacuum tests on the mockups in accordance with 462-8.2.1 prior to wax injection. For the wax injection operations, utilize the same wax material and types and sizes of wax injection equipment that will be used on the project including but not

limited to heaters, pumps, hoses, valves and pressure gauges. Inject wax into the mockups using the proposed Wax Injection Operations Plan. Allow the wax to cool a minimum of 24 hours after injection before inspecting the mockup. Inspect the mockup in accordance with the requirements of 462-8.3.2.2.1 and then carefully cut open the duct at all high points and other locations as directed by the Engineer to check for voids. Prepare a report documenting the findings and submit it to the Engineer. If voids are found, determine the cause and revise the proposed Wax Injection Operations Plan accordingly. If directed by the Engineer, construct additional mockups and repeat the wax injection operation using the revised Wax Injection Operations Plan as many times as are required until the results are acceptable.

SUBARTICLE 462-7.4.2.1.5.3 is deleted and the following substituted:

462-7.4.2.1.5.3 Wax Injection Operations:

1. Open all inlets, outlets, drains and ports before beginning the wax injection operation to remove standing water from duct. Capture and measure the water removed from the duct. Retain the water for further testing as directed by the Engineer~~If the volume of water is significant, as determined by the Engineer, then utilize compressed air, vacuuming, or other means deemed acceptable by the Engineer to dry the duct interior~~.

2. Close all ports except the inlet and outlet ports at the anchorage caps. Just prior to filler injection, blow oil-free dry compressed air through one of the anchorage cap ports to remove standing water, moisture or debris. Continue to blow oil-free dry compressed air until the humidity of air inside the duct is less than 40% measured at the downstream end of blowing.

~~2~~3. Protect concrete surfaces from wax spills, leaks, etc.

~~3~~4. Inject wax in accordance with approved Wax Injection Operations Plan.

~~4~~5. Use pumping methods that ensure complete filling of ducts and anchorage assembly with wax.

~~5~~6. Ensure the entire mass of wax is fully liquefied prior to and throughout injection operations. Establish a non-turbulent, laminar system circulation by continuously recirculating the wax between the pump and the storage container prior to injecting the wax into the duct. Pump components must be at wax injection temperature prior to wax injection into duct. Do not allow wax to free fall during recirculation or injection operations. Maintain a positive head of liquid wax above all withdrawal and recirculation ports and do not allow air intrusion into the pumping system. Do not pour liquid wax into an open pump or hopper.

~~6~~7. Inject PT wax at a continuous and steady rate in accordance with the approved Wax Injection Operations Plan at a flow rate through duct at a velocity between 40 and 70 feet per minute and pressure limited to 75 psi at the duct inlet and 145 psi at the pump.

~~7~~8. For tendons in which vacuum assisted injection is used, provide a minimum of 90% vacuum in the duct prior to injection. Connect both the anchorage outlet and the cap outlet to the vacuum system. After the vacuum is established, lock off the air supply to the duct and monitor the vacuum for 1 minute. If the loss of vacuum after

1 minute exceeds 10%, repair leaks as directed by the Engineer and retest the duct. If the results are acceptable, reestablish and maintain a minimum 90% vacuum using the outlets at the higher end anchorage shown on Standard Plans, Index 462-001 while injecting wax using the inlet at the lower end anchorage shown on the same Standard. Close all outlets, inlets, and ports other than at injection and vacuum locations during injection procedure. Pump wax into inlet and continuously vacuum air at the outlet. After the duct is fully injected with wax and the wax reaches the vacuum end, close the outlet valve, turn off the vacuum pump and continue the injection pump. Bleed all outlets starting at the anchorage cap at the injection end and proceed to bleed every valve thereafter from injection end to vacuum end, ending with the anchorage cap at the vacuum end. When bleeding each valve, collect a minimum of two gallons of continuously flowing wax free from air before closing the valve. After all outlet valves are closed, close inlet valve with locking pressure between 30 psi and 45 psi. Do not reuse discharged wax.

~~8~~9. For tendons in which vacuum assisted injection is not used, inject wax under pressure at locations shown on Standard Plans, Index 462-001. Allow wax to flow from duct and anchorage discharge points until a steady flow of wax free from air is continuously discharged. Collect a minimum of two gallons of continuously flowing wax free from air at discharge point before closing outlet valve. Do not reuse discharged wax. After all outlets are closed, close the inlet valve at locking pressure between 30 and 45 psi.

~~9~~10. Record the total volume of wax injected into the system.

~~10~~11. Upon completion of wax injection, seal the duct in accordance with the approved PT system drawings. Remove all excess wax from exposed surfaces.

SUBARTICLE 462-7.4.2.1.5.4 is deleted and the following substituted:

462-7.4.2.1.5.4 Wax Injection Operations Report:

1. Submit the wax injection report signed by the wax injection Contractor within five days of each wax injection operation for review by the Engineer.

2. Record theoretical quantity of wax anticipated as compared to actual quantity of wax used to fill duct. Notify the Engineer immediately of shortages or overages.

3. Information to be noted in this report must include at a minimum, but not necessarily be limited to:

a. Identification of duct;
b. Date of duct pressure test;
c. Date wax injected;
d. Number of days from tendon installation to wax injection;
e. Wax product identification;
f. Verification that water or moisture is not present within the duct;
g. Duct humidity readings;
~~f~~h. Pressure gauge readings at the pump and at the inlet;

~~g~~i. Final locking pressure of wax in PT system;

~~h~~j. Reservoir temperature at time of initiation of wax injection;

~~i~~k. Theoretical volume of wax required to completely fill the duct;

~~j~~l. Volume of wax injected into duct;

~~k~~m. Volume of wax collected at discharge points;

~~l~~n. Injection rate including timing of duct inlet opening and closing;

~~m~~o. Ambient temperature;

~~n~~p. Summary of any problems encountered and any deviations from the Wax Injection Operations Plan;

~~o~~q. Corrective action taken;

~~p~~r. Description and results of the post wax injection operations and inspection;

~~q~~s. Vacuum gauge pressure and percent vacuum in duct prior to injection;

4. Maintain daily wax injection operations reports at the job site for review by the Engineer. Submit all daily reports to the Engineer on a weekly basis or as directed by the Engineer.

SUBARTICLE 462-8.2.1.1is deleted and the following substituted:

462-8.2 Contractor Field Tests:

462-8.2.1 Prior to Concrete Placement:

462-8.2.1.1 All Tendons Except as Noted:

1. Test all PT system components utilized on the project, except those used for internal longitudinal tendons in precast box-girder segments in the casting cell (e.g., cantilever tendons).

2. In the formwork, pressure test each duct with all assemblies used in a single structural component (e.g. segment, beam, etc.).

3. Test assemblies in their final position just prior to concrete placement by sealing them at their anchorages or construction joint termini and then applying compressed air in accordance with this Section to determine if assembly connections are pressure tight.

4. In presence of the Engineer, pressurize duct to 7.5 psi and lock-off outside air source. Record pressure loss for one minute. If pressure loss exceeds 0.75 psi, or 10%, find and repair leaks in duct assembly using repair methods approved by the Engineer and retest.