EXPECTED IMPLEMENTATION JULY 2017

DRAFT

462 POST-TENSIONING.
(REV 12-27-16) (FA 1-6-17) (7-17)

ARTICLE 462-5 is deleted and the following substituted:

462-5 Submittals.

462-5.1 Shop and Working Drawings:

1. Submit to the Engineer all necessary information, Plans, shop and working drawings, and manuals in accordance with this Section and Section 5. Submit to the Engineer signed and sealed PT related shop drawings designed by the Contractor's Engineer of Record.

2. Prepare shop drawings addressing all requirements stated in the Contract Documents and requirements of this Section. Indicate pre-approved PT systems to be used as shown on the SDO website for Approved Post-Tensioning Systems. Show details of tendon geometry and locations complying with the Contract Documents and limitations of selected PT system. Include all inlets, outlets, high point inspection port details, anchorage inspection details, permanent anchorage caps, protection system materials, and application limits.

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 Design Standards, Index No. 21801:

a. Top of tendon anchorage;
b. Top 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.

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.

EXPECTED IMPLEMENTATION JULY 2017

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SUBARTICLE 462-7.4.1.1 is deleted and the following substituted:

462-7.4.1.1 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. Method to be used to control rate of flow within ducts;

g. Theoretical grout volume calculations;

h. 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. 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 462-7.4.2.1.1 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. Location and sequence of ducts to be injected;

e. Calculation of temporary elongation of tendons due to wax injection temperature;

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

g. Duct pressure test and repair procedures;

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

i. Theoretical wax volume calculations;

j. Injection rate;

k. Maximum injection pressure during injection and locking pressure;

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

m. Heating, mixing and pumping procedures in accordance with the manufacturer’s recommendations;

n Direction of wax injection accounting for grade and/or slope of tendon;

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

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

q. Procedures for handling blockages;

r. Procedure for sealing duct after wax injection;

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

t. Procedures for possible post injection repair;

u. 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;

v. 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. 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 Operations:

1. Open all inlets, outlets, drains and ports before beginning wax injection operation to remove standing water from duct.

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

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

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

5. 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. 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. 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 Design Standards, Index No. 21801 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 until duct is fully injected with wax. Close outlet valve at anchorage when filled with wax. Close inlet valve with locking pressure between 30 psi and 45 psi. Do not reuse discharged wax.

8. For tendons in which vacuum assisted injection is not used, inject wax under pressure at locations shown on Design Standards, Index No. 21801. 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. Record the total volume of wax injected into the system.

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

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. Pressure gauge readings at the pump and at the inlet;
g. Final locking pressure of wax in PT system;
h. Reservoir temperature at time of initiation of wax injection;
i. Theoretical volume of wax required to completely fill the duct;
j. Volume of wax injected into duct;
k. Volume of wax collected at discharge points;
l. Injection rate including timing of duct inlet opening and closing;
m. Ambient temperature;
n. Summary of any problems encountered and any deviations from the Wax Injection Operations Plan;
o. Corrective action taken;
p. Description and results of the post wax injection operations and inspection;
q. 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 462-7.5.2 is deleted and the following substituted:

462-7.5.2 Inlets, Outlets, Drains and Ports:

1. Place threaded plastic plugs in all inlet, outlet, drain and port locations required in the Contract Documents.

2. Fill inlet, outlet, drain and port recesses as shown in the Contract Documents using a Type Q epoxy compound, Type E epoxy compound, or Type F-1 epoxy compound meeting requirements of Section 926.

3. Prepare surface to receive epoxy compounds in compliance with manufacturer's recommendations.

SUBARTICLE 462-8.3.2 is deleted and the following substituted:

462-8.3.2 Post Filler Injection Operations:

462-8.3.2.1 Post Grouting Operations:

1. Inspect all tendons. Complete the inspection of a given tendon within 96 hours after grouting of that tendon.

2. Do not open or remove inlets, outlets, drains or ports until grout has cured for a minimum of 24 hours.

3. Perform inspections within one hour after removal of all inlets and outlets and drains located at anchorages and points along the tendon.

4. Drill into grout ports at all high points along tendon as well as inlets or outlets located at anchorages for inspection. Drill through hardened grout to penetrate full-length of grout port access piping to top of trumpet or duct. If drilling of inlets or outlets is not feasible with conventional equipment, propose an alternative method of tendon inspection for approval by the Engineer in writing. Use drilling equipment that will automatically shut-off when steel is encountered. Do not drill into anchorage cap unless anchorage caps are determined to have voids by sounding.

5. Perform all inspections using borescopes or probes and in presence of the Engineer.

6. Fill voids using volumetric measuring vacuum grouting process not less than 48 hours prior to the maximum number of calendar days in 462-7.2.4 allowed between first installation of prestressing steel within duct and completion of the stressing and grouting operation for PT. If the maximum number of days in 462-7.2.4 have been exceeded, have vacuum grouting equipment and experienced operators available within 48 hours notice.

7. Seal and repair all anchorage and inlet/outlet voids that are produced by drilling for inspection purposes as specified within four hours of completion of inspections if no additional voids are detected in tendon ducts or anchorages.

8. Remove inlet/outlet to a minimum depth of two inches below face of concrete and seal the surface as specified within 4 hours of inlet/outlet removal. Use an injection tube to extend to bottom of holes for backfilling with epoxy grout.

9. Drill into duct and explore voided areas with a borescope if grouting operations were prematurely terminated prior to completely filling duct. Probing is not allowed. Determine location and extent of all voided areas. Fill voids using volumetric measuring vacuum grouting equipment in accordance with this Section.

462-8.3.2.2 Post Flexible Filler Injection Operations:

462-8.3.2.2.1 Microcrystalline Wax:

1. Inspect all tendons. Complete the inspection of a given tendon within 96 hours after injecting that tendon with wax.

2. Do not open or remove inlets, outlets, drains or ports until wax has cooled for a minimum of 24 hours.

3. Perform inspections within one hour after removal of all inlets/outlets located at anchorages and high points along the tendon.

4. Visually inspect existing ports at all high points along tendon as well as inlets and outlets located at anchorages. Repair wax leaks according to the Wax Injection Operations Plan.

5. Between 24 and 48 hours following wax injection, perform the following inspection operations for each tendon:

a. Sound external ducts with a rubber mallet to ensure the system is free from voids,

b. Remove all inspection port caps and visually inspect to ensure the system is free from voids,

c. If a void is detected and the void is deeper than 1/2 inch or if the strands are exposed and uncoated, address the void using this section and methods described in the approved Wax Injection Operations Plan;

d. Fill voids created by inspection procedures and replace all inspection port caps and seal in accordance with the approved Wax Injection Operations Plan.

6. Fill voids using volumetric measuring vacuum wax injection process not less than 48 hours prior to the maximum number of calendar days in 462-7.2.4 allowed between first installation of prestressing steel within duct and completion of the stressing and wax injection operation for PT. If the maximum number of days in 462-7.2.4 have been exceeded, have vacuum wax injection equipment and experienced operators available within 48 hours notice.

7. Seal and repair all anchorage and inlet, outlet and port voids that are produced for inspection purposes as described in the approved Wax Injection Operations Plan within four hours of completion of inspections if no additional voids are detected in tendon ducts or anchorages.

8. Inspect duct and explore voided areas with a borescope if wax injection operation was prematurely terminated prior to completely filling duct. Determine location and extent of all voided areas. Fill voids using volumetric measuring vacuum wax injection equipment in accordance with this Section.

SUBARTICLE 462-10.1 is deleted and the following substituted:

462-10.1 General:

1. PT tendons will be paid for at the Contract unit price per pound of steel tendon, completed and accepted.

2. Payment will be full compensation for furnishing, installing, stressing, and filler injection of all temporary and permanent, internal and external ducts. Payment also includes anchorage assemblies and associated supplemental reinforcing steel required by supplier, PT system hardware not embedded in concrete, ducts, grout and grouting operations, flexible filler and filler injection operations, all testing, including construction of and filler injection into mockups, Tendon Modulus of Elasticity Test and In-Place Wobble and Friction Test, protection of PT anchorages, inlets, outlets, drains and all labor, materials, tools, equipment, and incidentals necessary for completing the work in accordance with the Contract Documents. This payment also includes lubricants in tendon ducts for friction control and flushing lubricants or contaminants from ducts.

3. Anchorage components, ducts, and similar items of PT system hardware embedded within precast components or cast-in-place concrete will be deemed to be included in cost of precast component or cast-in-place concrete in which it is embedded.

4. Payment is based on unit price bid extended by either quantities shown in the Contract Documents or actual quantities used and accepted, whichever is less, if the Contractor constructs structure with an accepted alternate not detailed in the Contract Documents.

5. Permanent PT strand, wire, or bar tendons which are an integral part of individual precast concrete segments or units will be measured and paid for under this item and will not be considered incidental to cost of those precast concrete segments or units.

6. Payment for PT will be made following successful placement, stressing, filler injection, inspection, repair, protection, and written approval by the Engineer.

7. Full payment for PT tendons within precast segmental concrete structure units may occur prior to erection of segments into final position when ducts have been injected and anchorage protection system applied and the segmental unit otherwise approved in writing for placement by the Engineer.