



Florida Department of Transportation

RICK SCOTT
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

ANANTH PRASAD, P.E.
SECRETARY

May 10, 2013

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

Re: Office of Design, Specifications
Section **462**
Proposed Specification: **4620704 Post-Tensioning.**

Dear Ms. Gourdine:

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

These changes were proposed by Steve Plotkin of the State Construction Office to modify and clarify the language for vacuum grouting in post-tensioning operations.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to SP965TT or trey.tillander@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4140.

Sincerely,

Signature on file

V. Y. "Trey" Tillander, III, P.E.
Manager, State Specifications and Estimates Office

TT/dt

Attachment

cc: Florida Transportation Builders' Assoc.
State Construction Engineer

POST-TENSIONING.**(REV 3-5-13)**

SUBARTICLE 462-7.4.4 (Pages 641 – 642) is deleted and the following substituted:

462-7.4.4 Equipment:

(a) Provide grouting equipment consisting of measuring devices for water, a high-speed shear colloidal mixer, a storage hopper (e.g., holding reservoir) and pump with all necessary connecting hoses, valves, and pressure gauge.

(b) Provide pumping equipment with sufficient capacity to ensure PT ducts can be filled and vented in not more than 30 minutes without interruption.

(c) Provide an air compressor and hoses with sufficient output to perform required functions.

(d) *Have vacuum grouting equipment (i.e., volumetric measuring type) and experienced operators available not less than 48 hours prior to the maximum number of calendar days allowed in 462-7.2.4, between first installation of prestressing steel within the 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 available vacuum grouting equipment (i.e., volumetric measuring type) and experienced operators available within 48 hours notice.*

462-7.4.4.1 Mixer and Storage Hopper:

(a) Provide colloidal grout machinery with a charging tank for blending and a holding tank. Blending tank must be equipped with a high speed shear colloidal mixer capable of continuous mechanical mixing producing a homogeneous and stable grout free of lumps and un-dispersed cement. Holding tank must be kept agitated and at least 10% full at all times during pumping operations to prevent air from being drawn into duct.

(b) Add water during primary mixing phase in the colloidal mixer by use of a flow meter or calibrated water reservoir with measuring accuracy equal to 1% of total water volume.

462-7.4.4.2 Pumps:

(a) Provide pumping equipment capable of (1) continuous operation which includes a system for circulating and agitating grout when actual grouting is not in progress and (2) maintaining pressure on grouted ducts and (3) fitted with a valve that can be closed off without loss or pressure in duct.

(b) Grout pumps will (1) be positive displacement type, (2) provide a continuous grout flow, and (3) be able to maintain a discharge pressure of at least 145 psi.

(c) Use pumps constructed with seals to prevent oil, air, or other foreign substances from contaminating grout and prevent loss of grout or water.

(d) Specify pump capacity adequate to maintain the specified grouting rate.

(e) Place pressure gauge with full scale reading of no more than 300 psi at duct inlet. If long hoses (in excess of 100 feet) are used, provide two gauges: one at pump and one at inlet.

(f) Grout hoses to be compatible with pump output (diameter and pressure rating).

462-7.4.4.3 Vacuum Grouting:

Provide vacuum grouting equipment meeting these minimum requirements:

(1) Volumeter for measurement of void volume;
 (2) Vacuum pump with a minimum capacity of ten cubic feet per minute and equipped with *a flow-meter, graduated hopper, or other acceptable means approved by the Engineer* capable of measuring *the* amount of grout being injected.

(3) Manual colloidal mixers, ~~and/or dissolvers (e.g., manual high speed shear mixers)~~, *or other mixing methods recommended and approved by the grout manufacturer, in writing, for the specific project covered by this Section* for voids less than ~~five~~ 5.5 gallons in volume; *However, mix a minimum of one full bag of grout regardless of the size void to be grouted.*

(4) Standard colloidal mixers for voids ~~five~~ 5.5 gallons and greater in volume.

462-7.4.4.4 Standby Equipment:

Provide a standby colloidal grout mixer and pump during grouting operations.

SUBARTICLE 462-7.4.5 (Pages 642 – 645) is deleted and the following substituted:

462-7.4.5 Grouting:

(a) Maintain grout fluidity in strict compliance with grout manufacturer's recommendations.

(b) In the presence of the Engineer, perform *a* test to confirm accuracy of grouting equipment volume-measuring components each day of use before performing any grouting operations. *Testing in a warehouse or similar condition is acceptable.* Use either water or grout for testing using standard testing devices with volumes of 0.5 gallon and 6.5 gallon and an accuracy of equal to or less than four ounces. Perform one test with each device. Results must verify accuracy of grouting equipment void volume-measuring component within ~~±5~~ 5% of test device volume and must verify accuracy of grouting equipment grout volume component within ~~5~~ 10% of test device volume *for the 0.5 gallon test device. When testing the 6.5 gallon device, ensure an accuracy of 3% (test device volume) and 6% (grout volume).*

(c) Do not use grout that tests outside allowable flow rates.

(d) Perform grouting in accordance with procedures set forth in approved Grouting Operations Plan.

(e) Grout all ducts.

462-7.4.5.1 Temperature:

(a) At inlet end of grout hose, the maximum limit for grout temperature is 90°F for normal grouting procedures and 85°F when performing repair operations with vacuum grouting.

(b) Condition grout material to maintain mixed grout temperature below maximum limit.

(c) Grouting operations are not permitted when ambient temperature is below 40°F or is expected to fall below 40°F within one day subsequent to grouting.

(d) Postpone grouting operations if freezing temperatures are forecasted within two days subsequent to grouting.

462-7.4.5.2 Mixing and Pumping:

(a) Mix grout with a metered amount of water.

(b) Mix materials to produce a homogeneous grout.

(c) Continuously agitate grout until grouting operations are complete.

(d) Reject bags of grout containing clumps.

462-7.4.5.3 Production Test:

(a) Test grout fluidity to verify it is within limits established by grout manufacturer during grouting operations. Target fluidity rate is established by manufacturer's representative based on ambient weather conditions.

(b) Determine grout fluidity in accordance with

Section 938.

(1) Perform a fluidity test using flow cone on grout discharged from anchorage cap outlet immediately after uncontaminated uniform consistency discharge begins for each tendon greater than 50 feet in length. For tendons 50 feet or less, perform a fluidity test on a per batch basis. For fluidity tests done on a per batch basis, perform test after new batch has been transferred from mixing tank to holding tank and thoroughly mixed with remains of the previous batch to produce a new homogenous mixture. During mixing process, continually re-circulate grout from hose into holding tank. Ensure measured grout efflux time is not less than efflux time measured at injection end of grout hose.

(2) Alternately, check grout fluidity using Wet Density method contained in Section 938. Density at discharge outlet must not be less than grout density at inlet. Continuously discharge grout until density requirements are met. Discard grout used for testing fluidity.

(c) Perform fluidity test for each tendon to be grouted without modifying water-cement ratio.

(d) Check temperature of grout at inlet end of grout hose hourly to verify conformance to this Section.

(e) Obtain a sample from first production batch of grout and perform a wick induced bleed test on this sample in accordance with Section 938 at beginning of each day's grouting operation. Begin grouting operations after sample is obtained.

(f) Once grouting has begun, if zero bleed requirement is found to not have been achieved in the wick induced bleed test at any time during required test time period, complete grouting of any partially grouted tendons currently being grouted but do not begin grouting any new or additional tendons. Immediately inform the Engineer when grouting operations have ceased due to non-compliance of the wick induced bleed test.

(g) Do not re-start grouting operations until such time that testing shows grout meets specified requirements.

462-7.4.5.4 Operations:

(a) Open all grout outlets before starting grouting operation.

(b) Grout tendons in accordance with approved Grouting Operations Plan.

(c) Pump grout at the lowest possible pressure practical.

(d) Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at grout inlet.

(e) Do not exceed maximum pumping pressure of 145 psi at grout inlet for round ducts and 75 psi for flat ducts.

(f) Use grout pumping methods that ensure complete filling of ducts and complete encasement of steel.

(g) Grout must flow from first and subsequent outlets until any residual water or entrapped air has been removed prior to closing outlet.

(h) 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.

(i) Elevate grout pressure to the equivalent realized pumping pressure while grouting the tendon, 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 tendon 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.

(j) 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.

(k) 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.

462-7.4.5.5 Vertical Grouting:

(a) Provide a reservoir, equivalent to a minimum of 2% of the total anticipated grout volume used on a particular tendon, at upper end of tendon to store bleed water and grout; maintain grout level above level of prestressing plate and anchorage for all vertical tendons. Design and size this device to maintain level grout at

an elevation that ensures potential bleed will not drop below the highest point of upper anchorage device. Design reservoir to allow all bleed water, if any, to rise into reservoir.

(b) Discharge grout and check grout fluidity as described in this Section. Immediately add grout if level of grout begins to drop, potentially allowing bleed water into the upper anchorage device and tendon duct. Remove reservoir after grout has hardened. Visually inspect for voids using an endoscope or probe in presence of the Engineer. Fill all voids found in duct using volumetric measuring vacuum grouting process in accordance with this Section.

(c) Allow grout to flow from each outlet until all air and water have been purged prior to using a higher elevation outlet for pumping. Pump grout at increasingly higher outlets which have been or are ready to be closed, as long as one-way grout flow is maintained for vertical tendons within allowable grouting pressures.

462-7.4.5.6 Grouting Operations Report:

(a) Provide grouting report signed by the grouting Contractor within five days of each grouting operation for review by the Engineer.

(b) 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.

(c) Information to be noted in this report must include at a minimum, but not necessarily be limited to: (1) identification of tendon; (2) date grouted; (3) number of days from tendon installation to grouting; (4) type of grout; (5) injection end and applied grouting pressure; (6) ratio of actual to theoretical grout quantity; (7) number of grout bags mixed; (8) total quantity of water used to mix grout; (9) summary of any problems encountered; and, (10) corrective action taken, (11) description and results of the post grouting operations and inspection.

SUBARTICLE 462-8.3.2 (Page 649) is deleted and the following substituted:

462-8.3.2 Post Grouting Operations:

(a) Inspect all tendons.

(b) Do not open or remove inlets and outlets until grout has cured for a minimum of 24 hours *and complete tendon inspections within 96 hours.*

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

(d) Drill into existing 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.

(e) Perform all inspections using endoscopes or probes and in presence of the Engineer.

(f) Fill voids using volumetric measuring vacuum grouting process *within-not less than 48 hours if voids are detected in tendon ducts or anchorages during inspection 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.

(g) 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.

(h) 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 compound.

(i) Drill into duct and explore voided areas with an endoscope if tendon grouting operation were prematurely terminated prior to completely filling tendon. 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.

POST-TENSIONING.**(REV 3-5-13)**

SUBARTICLE 462-7.4.4 (Pages 641 – 642) is deleted and the following substituted:

462-7.4.4 Equipment:

(a) Provide grouting equipment consisting of measuring devices for water, a high-speed shear colloidal mixer, a storage hopper (e.g., holding reservoir) and pump with all necessary connecting hoses, valves, and pressure gauge.

(b) Provide pumping equipment with sufficient capacity to ensure PT ducts can be filled and vented in not more than 30 minutes without interruption.

(c) Provide an air compressor and hoses with sufficient output to perform required functions.

(d) Have vacuum grouting equipment (i.e., volumetric measuring type) and experienced operators available not less than 48 hours prior to the maximum number of calendar days allowed in 462-7.2.4, between first installation of prestressing steel within the 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 available vacuum grouting equipment and experienced operators available within 48 hours notice.

462-7.4.4.1 Mixer and Storage Hopper:

(a) Provide colloidal grout machinery with a charging tank for blending and a holding tank. Blending tank must be equipped with a high speed shear colloidal mixer capable of continuous mechanical mixing producing a homogeneous and stable grout free of lumps and un-dispersed cement. Holding tank must be kept agitated and at least 10% full at all times during pumping operations to prevent air from being drawn into duct.

(b) Add water during primary mixing phase in the colloidal mixer by use of a flow meter or calibrated water reservoir with measuring accuracy equal to 1% of total water volume.

462-7.4.4.2 Pumps:

(a) Provide pumping equipment capable of (1) continuous operation which includes a system for circulating and agitating grout when actual grouting is not in progress and (2) maintaining pressure on grouted ducts and (3) fitted with a valve that can be closed off without loss or pressure in duct.

(b) Grout pumps will (1) be positive displacement type, (2) provide a continuous grout flow, and (3) be able to maintain a discharge pressure of at least 145 psi.

(c) Use pumps constructed with seals to prevent oil, air, or other foreign substances from contaminating grout and prevent loss of grout or water.

(d) Specify pump capacity adequate to maintain the specified grouting rate.

(e) Place pressure gauge with full scale reading of no more than 300 psi at duct inlet. If long hoses (in excess of 100 feet) are used, provide two gauges: one at pump and one at inlet.

(f) Grout hoses to be compatible with pump output (diameter and pressure rating).

462-7.4.4.3 Vacuum Grouting:

Provide vacuum grouting equipment meeting these minimum requirements:

(1) Volumeter for measurement of void volume;
(2) Vacuum pump with a minimum capacity of ten cubic feet per minute and equipped with a flow-meter, graduated hopper, or other acceptable means approved by the Engineer capable of measuring the amount of grout being injected.

(3) Manual colloidal mixers, manual high speed shear mixers, or other mixing methods recommended and approved by the grout manufacturer, in writing, for the specific project covered by this Section for voids less than 5.5 gallons in volume. However, mix a minimum of one full bag of grout regardless of the size void to be grouted.

(4) Standard colloidal mixers for voids 5.5 gallons and greater in volume.

462-7.4.4.4 Standby Equipment:

Provide a standby colloidal grout mixer and pump during grouting operations.

SUBARTICLE 462-7.4.5 (Pages 642 – 645) is deleted and the following substituted:

462-7.4.5 Grouting:

(a) Maintain grout fluidity in strict compliance with grout manufacturer's recommendations.

(b) In the presence of the Engineer, perform a test to confirm accuracy of grouting equipment volume-measuring components each day of use before performing any grouting operations. Testing in a warehouse or similar condition is acceptable. Use either water or grout for testing using standard testing devices with volumes of 0.5 gallon and 6.5 gallon and an accuracy of equal to or less than four ounces. Perform one test with each device. Results must verify accuracy of grouting equipment void volume-measuring component within 5% of test device volume and must verify accuracy of grouting equipment grout volume component within 10% of test device volume for the 0.5 gallon test device. When testing the 6.5 gallon device, ensure an accuracy of 3% (test device volume) and 6% (grout volume).

(c) Do not use grout that tests outside allowable flow rates.

(d) Perform grouting in accordance with procedures set forth in approved Grouting Operations Plan.

(e) Grout all ducts.

462-7.4.5.1 Temperature:

(a) At inlet end of grout hose, the maximum limit for grout temperature is 90°F for normal grouting procedures and 85°F when performing repair operations with vacuum grouting.

(b) Condition grout material to maintain mixed grout temperature below maximum limit.

(c) Grouting operations are not permitted when ambient temperature is below 40°F or is expected to fall below 40°F within one day subsequent to grouting.

(d) Postpone grouting operations if freezing temperatures are forecasted within two days subsequent to grouting.

462-7.4.5.2 Mixing and Pumping:

(a) Mix grout with a metered amount of water.

(b) Mix materials to produce a homogeneous grout.

(c) Continuously agitate grout until grouting operations are complete.

(d) Reject bags of grout containing clumps.

462-7.4.5.3 Production Test:

(a) Test grout fluidity to verify it is within limits established by grout manufacturer during grouting operations. Target fluidity rate is established by manufacturer's representative based on ambient weather conditions.

(b) Determine grout fluidity in accordance with

Section 938.

(1) Perform a fluidity test using flow cone on grout discharged from anchorage cap outlet immediately after uncontaminated uniform consistency discharge begins for each tendon greater than 50 feet in length. For tendons 50 feet or less, perform a fluidity test on a per batch basis. For fluidity tests done on a per batch basis, perform test after new batch has been transferred from mixing tank to holding tank and thoroughly mixed with remains of the previous batch to produce a new homogenous mixture. During mixing process, continually re-circulate grout from hose into holding tank. Ensure measured grout efflux time is not less than efflux time measured at injection end of grout hose.

(2) Alternately, check grout fluidity using Wet Density method contained in Section 938. Density at discharge outlet must not be less than grout density at inlet. Continuously discharge grout until density requirements are met. Discard grout used for testing fluidity.

(c) Perform fluidity test for each tendon to be grouted without modifying water-cement ratio.

(d) Check temperature of grout at inlet end of grout hose hourly to verify conformance to this Section.

(e) Obtain a sample from first production batch of grout and perform a wick induced bleed test on this sample in accordance with Section 938 at beginning of each day's grouting operation. Begin grouting operations after sample is obtained.

(f) Once grouting has begun, if zero bleed requirement is found to not have been achieved in the wick induced bleed test at any time during required test time period, complete grouting of any partially grouted tendons currently being grouted but do not begin grouting any new or additional tendons. Immediately inform the Engineer when grouting operations have ceased due to non-compliance of the wick induced bleed test.

(g) Do not re-start grouting operations until such time that testing shows grout meets specified requirements.

462-7.4.5.4 Operations:

(a) Open all grout outlets before starting grouting operation.

(b) Grout tendons in accordance with approved Grouting Operations Plan.

(c) Pump grout at the lowest possible pressure practical.

(d) Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at grout inlet.

(e) Do not exceed maximum pumping pressure of 145 psi at grout inlet for round ducts and 75 psi for flat ducts.

(f) Use grout pumping methods that ensure complete filling of ducts and complete encasement of steel.

(g) Grout must flow from first and subsequent outlets until any residual water or entrapped air has been removed prior to closing outlet.

(h) 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.

(i) Elevate grout pressure to the equivalent realized pumping pressure while grouting the tendon, 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 tendon 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.

(j) 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.

(k) 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.

462-7.4.5.5 Vertical Grouting:

(a) Provide a reservoir, equivalent to a minimum of 2% of the total anticipated grout volume used on a particular tendon, at upper end of tendon to store bleed water and grout; maintain grout level above level of prestressing plate and anchorage for all vertical tendons. Design and size this device to maintain level grout at

an elevation that ensures potential bleed will not drop below the highest point of upper anchorage device. Design reservoir to allow all bleed water, if any, to rise into reservoir.

(b) Discharge grout and check grout fluidity as described in this Section. Immediately add grout if level of grout begins to drop, potentially allowing bleed water into the upper anchorage device and tendon duct. Remove reservoir after grout has hardened. Visually inspect for voids using an endoscope or probe in presence of the Engineer. Fill all voids found in duct using volumetric measuring vacuum grouting process in accordance with this Section.

(c) Allow grout to flow from each outlet until all air and water have been purged prior to using a higher elevation outlet for pumping. Pump grout at increasingly higher outlets which have been or are ready to be closed, as long as one-way grout flow is maintained for vertical tendons within allowable grouting pressures.

462-7.4.5.6 Grouting Operations Report:

(a) Provide grouting report signed by the grouting Contractor within five days of each grouting operation for review by the Engineer.

(b) 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.

(c) Information to be noted in this report must include at a minimum, but not necessarily be limited to: (1) identification of tendon; (2) date grouted; (3) number of days from tendon installation to grouting; (4) type of grout; (5) injection end and applied grouting pressure; (6) ratio of actual to theoretical grout quantity; (7) number of grout bags mixed; (8) total quantity of water used to mix grout; (9) summary of any problems encountered; and, (10) corrective action taken, (11) description and results of the post grouting operations and inspection.

SUBARTICLE 462-8.3.2 (Page 649) is deleted and the following substituted:

462-8.3.2 Post Grouting Operations:

(a) Inspect all tendons.

(b) Do not open or remove inlets and outlets until grout has cured for a minimum of 24 hours and complete tendon inspections within 96 hours.

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

(d) Drill into existing 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.

(e) Perform all inspections using endoscopes or probes and in presence of the Engineer.

(f) 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.

(g) 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.

(h) 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 compound.

(i) Drill into duct and explore voided areas with an endoscope if tendon grouting operation were prematurely terminated prior to completely filling tendon. 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.