

ORINATION FORM

Proposed Revisions to the Specifications

(Please provide all information - incomplete forms will be returned)

Date: Specification Section:

Originator: Articles/Subarticles:

Telephone:

email:

Will the proposed revision involve Design Standard Index changes? Yes No

Roadway Design staff contacted (name):

Structures Design staff contacted (name):

Will the proposed revision involve PPM changes? Yes No

Roadway Design staff contacted (name):

Will the proposed revision involve CPAM changes? Yes No

Construction staff contacted (name):

Will the proposed revision involve Pay Item changes? Yes No

Estimates staff contacted (name):

Will the proposed revision involve SDG changes? Yes No

Structures staff contacted (name):

Will the proposed revision involve APL changes? Yes No

Product Evaluation staff contacted (name):

Will the proposed revision involve Material Manual changes? Yes No

State Materials Office staff contacted (name):

Will this revision necessitate any of the following:

Design Bulletin Construction Bulletin Estimates Bulletin Materials Bulletin

Are all references to external publications current? Yes No

If not, what references need to be updated? (Please include changes in the redline document.)

Why does the existing language need to be changed?

Summary of the changes:

Are these changes applicable to all Department jobs? Yes No

If not, what are the restrictions?

Contact the State Specifications Office for assistance in completing this form.

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MIKE DEW
INTERIM SECRETARY

MEMORANDUM

DATE: November 16, 2017

TO: Specification Review Distribution List

FROM: Dan Hurtado, P.E., State Specifications Engineer

SUBJECT: Proposed Specification: **4550503 Structures Foundations.**

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

This change was proposed by Juan Castellanos of the State Construction Office to clarify and update the language. The proposed revision also references a new section to Chapter 2 of the Materials Manual – Section 2.4, VII, Testing and Submittal Requirements for Polymer Slurry Products to be Used in Drilled Shaft Construction (see new link in 455-15.8.3).

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or online at <http://www2.dot.state.fl.us/ProgramManagement/Development/IndustryReview.aspx> . Comments received after **December 14, 2017**, may not be considered. Your input is encouraged.

DH/dt
Attachment

STRUCTURES FOUNDATIONS.

(REV ~~10-6-17~~11-7-17~~11-16-17~~)

SUBARTICLE 455-5.3.1 is deleted and the following substituted:

455-5.3.1 Air/steam: Variable energy air/steam hammers shall be capable of providing at least two ram stroke lengths. The short ram stroke length shall be approximately half of the full stroke for hammers with strokes up to 4 feet and no more than 2 feet for hammers with maximum strokes lengths over 4 feet. Operate and maintain air/steam hammers within the manufacturer's specified ranges. Use a plant and equipment for steam and air hammers with sufficient capacity to maintain, under working conditions, the hammer, volume and pressure specified by the manufacturer. Equip the plant and equipment with accurate pressure gauges which are easily accessible to the Engineer. The Engineer will not accept final bearing on piles the Contractor drives with air/steam hammers unless the Contractor operates the hammers within 10% of the manufacturer's rated speed in blows per minute, unless otherwise authorized by the Engineer. Provide and maintain in working order for the Engineer's use an approved device to automatically determine and display the blows per minute of the hammer.

ARTICLE 455-15 is deleted and the following substituted:

455-15 Construction Methods and Equipment.

455-15.1 General Requirements:

455-15.1.1 Templates: Provide a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations, when drilling from a barge. Do not use floating templates (attached to a barge). ~~The Engineer will not require a template for shafts drilled on land provided the Contractor demonstrates satisfactorily to the Engineer that shaft position and alignment can be properly maintained.~~ The Engineer will require a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations, for shafts drilled on land when the Contractor fails to demonstrate satisfactorily that he can properly maintain shaft position and alignment without use of a template.

455-15.1.2 Drilled Shaft Installation Plan (DSIP): At the preconstruction conference submit a ~~drilled shaft installation plan~~DSIP for review by the Engineer. Final approval will be subject to satisfactory performance. Include in this plan the following details:

1. Name and experience record of drilled shaft superintendent or foreman in responsible charge of drilled shaft operations. Ensure the drilled shaft superintendent or foreman in responsible charge of the drilled shaft operations has a minimum of one year of experience of installing drilled shafts of the size and depth shown in the Plans and a minimum of three years experience in the construction of drilled shafts using the following methods:
 - a. Wet Method (Mineral and polymer slurry),
 - b. Casings up to the length shown in the Plans,
 - c. Shaft drilling operations on water under conditions as shown in the Plans.

2. List and size of proposed equipment, including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, ~~and casings, etc.~~

3. Details of sequence of construction operations and sequence of shaft construction in bents or shaft groups.

4. Details of shaft excavation methods.

5. Details of slurry, including proposed methods to mix, circulate, desand, test methods, and proposed CTQP certified technician that will perform and document the fluid tests.

6. Details of proposed methods to clean ~~the shaft after initial~~ excavation.

7. Details of shaft reinforcement, including methods to ensure centering/required cover, cage integrity during placement, placement procedures, cage support, and tie downs.

8. Details of concrete placement, including elapsed concrete placement times and proposed operational procedures for concrete tremie or pump, including initial placement, raising during placement, and overfilling of the shaft concrete. Include provisions to ensure proper final shaft cutoff elevation.

9. Details of casing removal when removal is required, including minimum concrete head in casing during removal.

10. Required submittals, including shop drawing and concrete design mixes.

11. Details of any required load tests, including equipment and procedures, and recent calibrations for any jacks or load cells.

12. Proposed Cross-Hole Sonic Logging (CSL) ~~and Thermal Integrity Testing for Drilled (TITDS)~~ Specialty Engineer to ~~perform, log, analyze, supervise field testing~~ and report the test results.

13. Methods and equipment proposed to prevent displacement of casing and/or shafts during placement and compaction of fill.

14. Provide the make and model of the shaft inspection device, if applicable.

15. Details of environmental control procedures used to prevent loss of slurry or concrete into waterways or other protected areas.

16. Proposed schedule for test shaft installation, load tests and production shaft installation.

17. Other information shown in the Plans or requested by the Engineer.

18. For drilled shafts ~~for sign, signal, lighting and ITS structures~~ constructed using polymer slurry, identify the polymer slurry meeting the requirements of 455-15.8.23, the pH and viscosity ranges recommended by the manufacturer for the materials to be excavated and a description of the mixing method to be used. Submit the Material Safety Data Sheets (SDS) for the product, and certifications that the polymer slurry and components meet the requirements of 455-15.8.23. Submit the contact information for the manufacturer's representative available for immediate contact during shaft construction and the representative's schedule of availability.

19. Procedure for grouting ~~CSL non-destructive testing~~ access tubes.

The Engineer will evaluate the ~~drilled shaft installation plan~~ DSIP for conformance with the Contract Documents. Within 20 days after receipt of the plan, the Engineer

will notify the Contractor of any additional information required and/or changes that may be necessary in the opinion of the Engineer to satisfy the Contract Documents. The Engineer will reject any part of the plan that is unacceptable. Submit changes agreed upon for reevaluation. The Engineer will notify the Contractor within seven days after receipt of proposed changes of their acceptance or rejection. All equipment and procedures are subject to trial and satisfactory performance in the field.

Acceptance by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with the Contract Documents. The installation plan is for the Contractor to explain the approach to the work and allow the Engineer an opportunity to comment on the equipment and procedures chosen before field operations begin. The Engineer's acceptance is not a guarantee that the chosen methods and equipment are capable of obtaining the required results, this responsibility lies with the Contractor.

455-15.1.3 General Methods & Equipment: Perform the excavations required for the shafts, through whatever materials encountered, to the dimensions and elevations shown in the Contract Documents, using methods and equipment suitable for the intended purpose and the materials encountered. Provide drilling tools with a diameter not smaller than one inch of the shaft diameter required in the Plans ~~minus 1 inch~~. Provide equipment capable of constructing shafts supporting bridges to a depth equal to the deepest shaft shown in the Plans plus 15 feet or plus three times the shaft diameter, whichever is greater, except when the Plans require equipment capable of constructing shafts to a deeper depth. Provide equipment capable of constructing shafts supporting non-bridge structures, including sign, signal, lighting and ITS structures, to a depth equal to the deepest shaft shown in the Plans plus 5 feet.

Construct drilled shafts according to the Contract Documents using generally either the dry method, wet method, casing method, or permanent casing method as necessary to produce sound, durable concrete foundation shafts free of defects. Use the permanent casing method only when required by the Plans or authorized by the Engineer. When the Plans describe a particular method of construction, use this method except when permitted otherwise by the Engineer, after field trial. When the Plans do not describe a particular method, propose a method on the basis of its suitability to the site conditions and submit it for approval by the Engineer.

Set a suitable temporary removable surface casing from at least 1 foot above the ground surface to at least 1-1/2 shaft diameters below the ground surface to prevent caving of the surface soils and to aid in maintaining shaft position and alignment. Do not use a temporary casing ~~greater~~ larger than 12 inches of the shaft diameter of the reinforcing steel cage, plus 24 inches. Fill the oversized temporary casing with drilled shaft concrete at no additional expense to the Department. Withdraw the surface casing after concrete placement. The Engineer may require predrilling with slurry and/or overreaming to the outside diameter of the casing to install the surface casing at some sites.

For drilled shafts installed to support sign, signal, lighting and ITS structures, provide temporary surface casings from at least 1 foot above the ground surface to at least 5 feet below the ground surface. For sign, signal, lighting and ITS structure foundations located within permanent sidewalks or within 5 feet of curb sections, provide temporary surface casings from no lower than the top of sidewalk to at least 5 feet below the ground surface.

For drilled shafts installed to support sign, signal, lighting and ITS structures, ~~fill the excavation with premixed mineral slurry meeting the requirements of 455-15.8.1 or polymer slurry meeting the requirements of 455-15.8.2 before the drill advances to the~~

~~bottom of the temporary casing.~~ Do not attempt to excavate the shaft using plain water or natural slurry. Do not attempt to excavate the shaft using dry construction method unless specifically indicated in the Plans or approved by the Engineer.

455-15.2 Dry Construction Method: Use the dry construction method only at sites where the ground water table and soil conditions, generally stiff to hard clays or rock above the water table, make it feasible to construct the shaft in a relatively dry excavation and where the sides and bottom of the shaft are stable and may be visually inspected by the Engineer prior to placing the concrete.

In applying the dry construction method, drill the shaft excavation, remove accumulated seepage water and loose material from the excavation and place the shaft concrete in a relatively dry excavation.

Use the dry construction method only when shaft excavations, as demonstrated in a test hole, have 12 inches or less of seepage water accumulated over a four hour period, the sides and bottom remain stable without detrimental caving, sloughing, or swelling for a four hour period, and the loose material and water can be satisfactorily removed prior to inspection and prior to placing concrete. Use the wet construction method or the temporary casing construction method for shafts that do not meet the requirements for the dry construction method.

455-15.3 Wet Construction Method: Use the wet construction method at all sites where it is impractical to provide a dry excavation for placement of the shaft concrete.

The wet construction method consists of keeping the shaft excavation filled with fluid (mineral slurry, polymer slurry, natural slurry or water), desanding and cleaning the ~~mineral~~ slurry and final cleaning of the excavation by means of a bailing bucket, air lift, submersible pump or other approved devices and placing the shaft concrete (with a tremie or concrete pump extending to the shaft bottom) which displaces the water or slurry during concreting of the shaft excavation.

Where drilled shafts are located in open water areas, construct the shafts by the wet method using exterior casings extending from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing of the concrete. Install the exterior casing in a manner that will produce a positive seal at the bottom of the casing so that there is no intrusion or extrusion of water or other materials into or from the shaft excavation.

455-15.4 Temporary Casing Construction Method: Use the temporary casing method at all sites where it is inappropriate to use the dry or wet construction methods without the use of temporary casings other than surface casings. In this method, the casing is advanced prior to excavation and withdrawn after concrete placement. When a formation is reached that is nearly impervious, seal in the nearly impervious formation. Proceed with drilling as with the wet method to the projected depth. Proceed with the placement of the concrete as with the dry method. In the event seepage conditions prevent use of the dry method, complete the excavation and concrete placement using wet methods.

Where drilling through materials having a tendency to cave, advance the excavation by drilling in a mineral or polymer slurry. In the event that a caving layer or layers are encountered that cannot be controlled by slurry, install temporary removable casing through such caving layer or layers. The Engineer may require overreaming to the outside diameter of the casing. Take whatever steps are required to prevent caving during shaft excavation including installation of deeper casings. If electing to remove a casing and replace it with a longer casing through caving soils, backfill the excavation. The Contractor may use soil previously excavated

or soil from the site to backfill the excavation. The Contractor may use other approved methods which will control the size of the excavation and protect the integrity of the foundation soils to excavate through caving layers.

Before withdrawing the casing, ensure that the level of fresh concrete is at such a level that the fluid trapped behind the casing is displaced upward. As the casing is withdrawn, maintain the level of concrete within the casing so that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete.

The Contractor may use the casing method, when approved by the Engineer, to construct shafts through weak caving soils that do not contribute significant shaft shear resistance. In this case, place a temporary casing through the weak caving soils before beginning excavation. Conduct excavation using the dry construction method where appropriate for site conditions and the wet construction method where the dry construction method is not appropriate. Withdraw the temporary casing during the concreting operations unless the Engineer approves otherwise.

455-15.5 Permanent Casing Construction Method: Use the permanent casing method when required by the Plans. In this method, place a casing to the prescribed depth before beginning excavation. If the Contractor cannot attain full penetration, the Engineer may direct the Contractor to excavate through the casing and advance the casing until reaching the desired penetration. In some cases the Engineer may require the Contractor to overream to the outside diameter of the casing before placing the casing.

Construct the shaft in accordance with 455-15.4 except for cutting the casing off at the prescribed elevation upon reaching the proper construction sequence and leaving the remainder of the casing in place.

455-15.5.1 Temporary Extension of Permanent Casing: When the wet method does not provide enough support to excavate and clean the drilled shaft extension below the permanent casing tip elevations shown in the Plans, the permanent casing may be temporarily extended to an elevation deeper than the tip elevation at no additional expense to the Department. The rock socket length must be extended as specified in 455-15.7 and the casing raised to the original casing tip elevation shown in the Plans after the concrete placement. Include details of this procedure in the [Drilled Shaft Installation Plan DSIP](#) for the Engineer's review and approval.

455-15.5.2 Temporary Casing to Stabilize Excavation below Permanent Casing: To stabilize the excavation below the permanent casing tip elevation, a temporary casing inside an oversized permanent casing may be used at no additional expense to the Department. The permanent casing must have an inside diameter no more than 6 inches larger than the drilled shaft diameter specified in the Plans.

The following requirements apply:

1. Excavate and clean the materials from inside the permanent casing. Ensure all materials are removed from the inside wall of the permanent casing.
2. Install the temporary casing prior to excavating below the permanent casing tip elevation. The temporary casing must have a minimum internal diameter equal to the shaft diameter required in the Plans.
3. If the temporary casing is advanced deeper than the minimum top of rock socket elevation as shown in the Plans, or the top of rock elevation if deeper, extend the rock socket length in accordance with 455-15.7.

4. Place concrete in accordance with 455-15.9.3 through the temporary casing. Do not allow concrete to fall or overflow into the annular space between the temporary and permanent casing.

5. After placement of the concrete, remove the temporary casing in accordance with 455-15.4, 455-15. [97](#) and 455-17. During withdrawal of the temporary casing, maintain adequate concrete head in both the temporary and permanent casings to avoid breaching, caving, or contamination of the concrete.

Include details of this procedure in the [Drilled Shaft Installation Plan](#) [DSIP](#) for the Engineer's review and approval.

455-15.6 Excavations: When pilot holes and/or load tests are performed, the Engineer will use the pilot hole and/or load test results to determine the authorized tip elevations and/or the authorized installation criteria of the drilled shafts. Drilled shaft construction shall not begin until pilot hole and/or load test reports are approved by the Engineer. Shaft tip elevations based on pilot hole results and/or load tests may vary from the tip elevations presented in the Plans. Extend drilled shaft excavations deeper by extra depth excavation when the Engineer determines the material encountered while drilling the shaft excavation is unsuitable and/or is not the same as anticipated in the design of the drilled shaft. In the absence of suitable strength tests or load tests to evaluate materials excavated, construct the shafts no higher than the tip elevations shown in the Plans.

455-15.6.1 Pilot Hole: When pilot holes are shown in the Plans core a pilot hole, prior to shaft excavation, in accordance with ASTM D2113 Standard Practice for [DiamondRock](#) Core Drilling [and Sampling of Rock](#) for Site Excavation and the Department's Soils & Foundations Handbook using a double or triple wall core barrel through part or all of the shaft, to a depth of 3 times the diameter of the drilled shaft below the tip elevation shown in the Plans, as directed by the Engineer. The Engineer may require the Contractor to cut any core to a total depth below the bottom of the drilled shaft excavation of up to 5 times the diameter of the drilled shaft.

455-15.6.2 Cores: Take cores when shown in the Plans or directed by the Engineer to determine the character of the material directly below the shaft excavation. Provide equipment to retrieve the core from a depth of 5 times the diameter of the drilled shaft below the bottom of the drilled shaft excavation in accordance with ASTM D2113 Standard Practice for [DiamondRock](#) Core Drilling [and Sampling of Rock](#) for Site Excavation. Cut the cores with an approved core barrel to a minimum depth of 3 times the diameter of the drilled shaft below the bottom of the drilled shaft excavation after completing the shaft excavation, as directed by the Engineer. The Engineer may require the Contractor to cut any core to a total depth below the bottom of the drilled shaft excavation of up to 5 times the diameter of the drilled shaft.

For cores or pilot holes, use only a double or triple wall core barrel designed:

1. to cut a core sample from 4 inches to 6 inches in diameter, at least 5 feet in length, and,
2. so that the sample of material cored can be removed from the shaft excavation and the core barrel in an undisturbed state, ~~and~~.

The Engineer will inspect the cores and determine the depth of required excavation. When considered necessary by the Engineer, take additional cores. Place the core samples in suitable containers, identified by shaft location, elevation from and to, and job number, and deliver to the Department within 48 hours after cutting. When called for in the

Plans, substitute Standard Penetration Tests (SPT) for coring. In such cases, supply these tests at no additional cost per foot to the Department above that bid for core (shaft excavation).

Provide areas for the disposal of unsuitable materials and excess materials as defined in 120-5 that are removed from shaft excavations, and dispose of them in a manner meeting all environmental requirements ~~pertaining to pollution~~.

Furnish the additional drilled shaft concrete over the theoretical amount required to complete filling any excavations for shafts which are larger than required by the Plans or authorized by the Engineer, at no expense to the Department.

455-15.7 Casings: Ensure that casings are metal, of ample strength to withstand handling and driving stresses and the pressure of concrete and of the surrounding earth materials, and that they are smooth and water tight. Ensure that the inside diameter of casing is not less than the specified size of shaft except as provided below. The Department will not allow extra compensation for concrete required to fill an oversize casing or oversize excavation.

The Engineer will allow the Contractor to supply casing with an outside diameter equal to the specified shaft diameter (O.D. casing) provided ~~he supplies~~ additional shaft length is supplied at the shaft tip. Determine the additional length of shaft required by the following relationship:

$$\text{Additional Length} = \frac{(D_1 - D_2) L}{D_2}$$

where:

D₁ = casing inside diameter specified = shaft diameter specified

D₂ = casing inside diameter provided (D₂ = D₁ minus twice the wall thickness).

L = authorized shaft length below ground for temporary casing methods or below casing for permanent casing methods.

Bear all costs relating to this additional length including but not limited to the cost of extra excavation, extra concrete, and extra reinforcing steel.

Install and remove casing by rotating, exerting downward pressure, or with a vibratory hammer, unless otherwise shown in the Contract Documents. Remove all casings from shaft excavations except those used for the Permanent Casing Method. Ensure that the portion of casings installed under the Permanent Casing Method of construction below the shaft cut-off elevation remains in position as a permanent part of the drilled shaft. The Contractor may leave casings if in the opinion of the Engineer the casings will not adversely affect the shaft capacity in place. When casings that are to be removed become bound in the shaft excavation and cannot be practically removed, drill the shaft excavation deeper as directed by the Engineer to compensate for loss of capacity due to the presence of the casing. The Department will not compensate for the casing remaining. The Department will pay for the additional length of shaft under Pay Item No. 455-88.

If temporary casing is advanced deeper than the minimum top of rock socket elevation shown in the Plans or actual top of rock elevation if deeper, withdraw the casing from the rock socket and overream the shaft. If the temporary casing cannot be withdrawn from the rock socket before final cleaning, extend the length of rock socket below the authorized tip elevation one-half of the distance between the minimum top of rock socket elevation or actual elevation if deeper, and the temporary casing tip elevation.

~~When the shaft extends above ground or through a body of water, the Contractor may form the exposed portion with removable casing except when the Permanent Casing Method is specified (see 455-23.7). When approved, the Contractor may form drilled shafts extending through a body of water with permanent or removable casings. When the shaft extends above ground or a body of water, the Contractor may form the exposed portion with removable casing, unless otherwise specified in the Plans. However, for permanent casings, remove the portion of metal casings between an elevation 2 feet below the lowest water elevation or 2 feet below ground whichever is higher and the top of shaft elevation after the concrete is cured. Dismantle/Remove casings removed to expose the concrete as required above in a manner which will not damage the drilled shaft concrete. Dismantle removable casings in accordance with the provisions of 455-17.5.~~

~~Generally when removal of the temporary casing is required When practical, do not start the casing removal until completing all concrete placement in the shaft. The Engineer will permit movement of the casing by rotating, exerting downward pressure, and tapping it to facilitate extraction, or extraction with a vibratory hammer. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Withdraw temporary casings while the concrete remains fluid.~~

When conditions warrant, the Contractor may pull the casing in partial stages. Maintain a sufficient head of concrete above the bottom of the casing to overcome the hydrostatic pressure of water outside the casing. At all times maintain the elevation of the concrete in the casing high enough to displace the drilling slurry between the outside of the casing and the edge of the hole while removing the casing.

The Contractor may use special casing systems in open water areas, when approved, which are designed to permit removal after the concrete has hardened. Design special casings so that no damage occurs to the drilled shaft concrete during their removal.

Expandable or split casings that are removable are not permitted for use below water.

455-15.8 Slurry and Fluid in Excavation at Time of Concrete Placement:

455-15.8.1 General: Thoroughly premix the slurry with clean fresh water prior to introduction into the shaft excavation. Introduce slurry before the excavation advances below the bottom of the casing. Ensure that the percentage of polymer and/or mineral admixture used to make the suspension is such as to maintain the stability of the shaft excavation. The Engineer will require adequate water and/or slurry tanks when necessary to perform the work in accordance with these Specification sections. The Engineer will not allow excavated pits on projects requiring slurry tanks without the written permission of the Engineer. Take the steps necessary to prevent the slurry from "setting up" in the shaft; including, but not limited, to agitation, circulation, and/or adjusting the composition and properties of the slurry. Provide suitable offsite disposal areas and dispose of all waste slurry in a manner meeting all requirements pertaining to pollution.

Provide a CTQP qualified drilled shaft inspector to perform control tests using suitable apparatus on the slurry mixture to determine the slurry and fluid properties as specified in sub-articles 455-15.8.2 to 455-15.8.4.

Measure the viscosity of the freshly mixed slurry regularly as a check on the quality of the slurry being formed using an approved measuring device.

Perform tests from the fluid in the excavation to determine density, viscosity, and pH value to establish a consistent working pattern, taking into account the mixing

process and blending of freshly mixed slurry and previously used slurry. Perform a set of tests to determine density, viscosity, and pH value at intervals not exceeding 2- hours during the first 8 hours slurry is in use and one set every 4- hours thereafter. Perform one set of tests when the excavation reaches the midpoint.

The Department may perform comparison tests as determined necessary during the mineral and polymer slurry operations.

If, ~~At any time in the opinion of the Engineer, the wet construction method of stabilizing excavations fails, in the opinion of the Engineer,~~ to produce the desired final result, discontinue this method of construction, propose and ~~propose~~submit modifications in procedure or alternate means of construction for approval.

455-15.8.2 Mineral Slurry: When mineral slurry is used in an excavation, use only processed attapulgite or bentonite clays with up to 2% (by dry weight) of added polymer. Use mineral slurry having a mineral grain size such that it will remain in suspension and having sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Use a percentage and specific gravity of the material to make the suspension sufficient to maintain the stability of the excavation and to allow proper placement of concrete. Ensure that the material used to make the slurry is not detrimental to concrete or surrounding ground strata. During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry such that the slurry level cannot practically be maintained by adding slurry to the hole, backfill the excavation and delay the construction of that foundation until an alternate construction procedure has been approved.

~~Thoroughly premix the slurry with clean fresh water prior to introduction into the shaft excavation. Ensure that the percentage of mineral admixture used to make the suspension is such as to maintain the stability of the shaft excavation. The Engineer will require adequate water and/or slurry tanks when necessary to perform the work in accordance with these Specifications. The Engineer will not allow excavated pits on projects requiring slurry tanks without the written permission of the Engineer. Take the steps necessary to prevent the slurry from "setting up" in the shaft, including but not limited to agitation, circulation, and/or adjusting the composition and properties of the slurry. Provide suitable offsite disposal areas and dispose of all waste slurry in a manner meeting all requirements pertaining to pollution.~~

~~Provide a CTQP qualified drilled shaft inspector to perform control tests using suitable apparatus on the mineral slurry mixture to determine the following parameters:~~

~~1. Freshly mixed mineral slurry: Measure the density of the freshly mixed mineral slurry regularly as a check on the quality of the suspension being formed using a measuring device calibrated to read within plus or minus 0.5 pound per cubic foot.~~

~~2. Mineral slurry supplied to the drilled shaft excavation: Perform the following tests on the mineral slurry supplied to and in the shaft excavation and ensure that the results are within the ranges stated in the table below:~~

Item to be measured	Range of Results at 68°F	Test Method
Density	64 to 73 lb/ft ³ (in fresh water environment) 66 to 75 lb/ft ³ (in salt water environment)	Mud density balance: FM 8-RP13B-1
Viscosity	30 to 40 seconds	Marsh Cone Method: FM 8-RP13B-2
pH	8 to 11	Electric pH meter or pH indicator paper strips: FM 8-RP13B-4
Sand Content	4% or less	FM 8-RP13B-3

The Contractor may adjust the limits in the above table when field conditions warrant as successfully demonstrated in a test hole or with other methods approved by the Engineer. The Engineer must approve all changes in writing before the Contractor can continue to use them.

~~Perform tests to determine density, viscosity, and pH value to establish a consistent working pattern, taking into account the mixing process and blending of freshly mixed mineral slurry and previously used mineral slurry. Perform a minimum of four sets of tests to determine density, viscosity, and pH value during the first 8 hours mineral slurry is in use.~~

~~When the results show consistent behavior, discontinue the tests for pH value, and only carry out tests to determine density and viscosity during each four hours mineral slurry is in use. If the consistent working pattern changes, reintroduce the additional tests for pH value for the time required to establish consistency of the test values within the required parameters.~~

~~3. The Department may perform comparison tests as determined necessary during the mineral slurry operations.~~

During construction, maintain the level of mineral slurry in the shaft excavation within the excavation and at a level not less than 4 feet above the highest expected piezometric water pressure along the depth of a shaft.

~~At any time the wet construction method of stabilizing excavations fails, in the opinion of the Engineer, to produce the desired final result, discontinue this method of construction, and propose modifications in procedure or alternate means of construction for approval.~~

455-15.8.23 Polymer Slurry for Shafts for Sign, Signal, Lighting and ITS Structures: Materials manufactured expressly for use as polymer slurry for drilled shafts that meet the requirements of this subarticleSection may be used as slurry for drilled shaft excavations ~~installed to support sign, signal, lighting and ITS structures~~. A representative of the manufacturer must be on-site or available for immediate contact to assist and guide the construction of the first three drilled shafts at no additional cost to the Department. This representative must also be available for on-site assistance or immediate contact if problems are encountered during the construction of the remaining drilled shafts as determined by the Engineer. ~~The Engineer will not allow polymer slurries during construction of drilled shafts for bridge foundations.~~ Use polymer slurry only if the soils below the casing are not classified as organic, and the pH of the fluid in the hole can be maintained in accordance with the manufacturer's published recommendations. Submit the SDS for the product, the manufacturer's

published mixing procedures, and the manufacturer's published range of values for pH and viscosity of the mixed slurry. ~~Provide~~Submit a report in accordance with Section 2.4, Volume II of the Department's Material Manual, which may be viewed at the following URL: <http://www.fdot.gov/programmanagement/Implemented/URLinSpecs/Files/Section24VII-100517.pdf>.

~~The report must include test results, certification and~~ documentation ~~in accordance with the Materials Manual, Volume II, section 2.4,~~ that ~~demonstrate~~ the polymer slurry and ~~component~~additives meet the following requirements:

1. The polymer slurries to be used on the project and their waste products are classified as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) Subpart C rules, Table 1 of 40 CFR 261.24 Toxicity Characteristic.
2. Pull out tests demonstrate the bond between the bar reinforcement and the concrete is not materially affected by exposure to the slurry under typical construction conditions, over the typical range of slurry viscosities to be used.
3. Load tests demonstrate the bond between the concrete and the soil is not materially affected by exposure to the polymer slurry under typical construction conditions, over the typical range of polymer slurry viscosities to be used.
4. The method of disposal meets the approval of all federal, state and local regulatory authorities.

Perform the following tests on the polymer slurry ~~supplied to and~~ in the shaft excavation and ensure that the results are maintained within the ranges stated in the table below:

Mixed Polymer Slurry Properties		
Item to be measured	Range of Results at 68°F	Test Method
Density	62 to 65 lb/ft ³ (fresh water) 64 to 67 lb/ft ³ (salt water)	Mud density balance: FM 8-RP13B-1
Viscosity	Range Published <u>By</u> The <u>M</u> manufacturer, <u>limited by numbers 455-15.8.3-(2) and 455-15.8.3(3) above,</u> for <u>M</u> materials <u>Excavated</u>	Marsh Cone Method: FM 8-RP13B-2
pH	Range Published <u>By</u> The <u>M</u> manufacturer for <u>M</u> materials <u>Excavated</u>	Electric pH meter or pH indicator paper strips: FM 8-RP13B-4
Sand Content	0.5% or less	FM 8-RP13B-3

~~Premix p~~ Polymer slurry ~~may be mixed in the cased portion of the shaft in accordance with the manufacturer's published procedures. Test and verify the polymer slurry meets the above requirements before continuing the excavation below the casing.~~

During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole. ~~At any time the wet construction method of stabilizing excavations fails, in the opinion of the Engineer, to produce the desired final result, discontinue this method~~

~~of construction, and propose modifications in procedure or alternate means of construction for approval.~~

455-15.8.34 Fluid In Excavation At Time Of Concrete Placement: When any fluid is present in any drilled shaft excavation, including shafts to support sign, signal, lighting and ITS structures, the applicable test methods and reporting requirements described in 455-15.8.1, 455-15.8.2 and 455-15.8.3 apply to tests of fluid in the shaft prior to placing the concrete.

Take test samples of the fluid in the shaft from within 1 inch of the base of the shaft and from the middle of the shaft height for shafts up to 60 feet in depth. Test samples of the fluid in the shaft from within 1 inch of the base of the shaft and at intervals not exceeding 30 feet up the shaft; for shafts deeper than 60 feet. ~~Use~~ using an ~~approved~~ sampling tool, approved by the Engineer, designed to sample over a depth range of 12 inches or less. Take whatever action is necessary prior to placing the concrete to bring the fluid within the specification and reporting requirements, outlined in the tables in 455-15.8.~~12~~ and 455-15.8.3, except as follows:

The Engineer will not require tests for pH or viscosity, nor require the fluid to meet the minimum density specified in 455-15.8.~~2~~ and 455-15.8.3 when neither polymer nor mineral slurry has ~~not~~ been introduced into the shaft excavation.

~~When using polymer slurry to support the excavation for drilled shafts installed to support sign, signal, lighting and ITS structures, take whatever action is necessary prior to placing the concrete to bring the properties of the fluid within the ranges in 455-15.8.2.~~

~~Provide a CTQP qualified drilled shaft inspector to perform testing. The Department may also perform comparison tests. Provide equipment for such comparison tests when requested by the Engineer.~~

455-15.9 Tremies and Pumps:

455-15.9.1 General: The requirements of the applicable provisions of Section 400 will apply when using a tremie or a pump to place drilled shaft concrete.

455-15.9.2 Dry Excavations: Ensure that the tremie for depositing concrete in a dry drilled shaft excavation consists of a tube of solid construction, a tube constructed of sections which can be added and removed, or a tube of other approved design. The Contractor may pass concrete through a hopper at the top of the tube or through side openings as the tremie is retrieved during concrete placement. Support the tremie so that the free fall of the concrete is less than 5 feet at all times. If the free falling concrete causes the shaft excavation to cave or slough, control the movement of concrete by reducing the height of free fall of the concrete and/or reducing the rate of flow of concrete into the excavation.

455-15.9.3 Wet Excavations: Construct the tremie or pump line used to deposit concrete beneath the surface of water so that it is water-tight and will readily discharge concrete. Construct the discharge end of the tremie or pump line to prevent water intrusion and permit the free flow of concrete during placement operations. Ensure that the tremie or pump line has sufficient length and weight to rest on the shaft bottom before starting concrete placement.

During placement operations, ensure that the discharge end of the tremie or pump line is within 6 inches of the bottom of the shaft excavation until at least 10 feet of concrete has been placed. Ensure the discharge end of the tremie or pump line is continuously embedded at least 10 feet into the concrete after 10 feet of concrete has been placed and until the casing is overpoured sufficiently to eliminate all contaminated concrete. Ensure that the free fall of concrete into the hopper is less than 5 feet at all times. Support the tremie so that it can be raised to increase the discharge of concrete and lowered to reduce the discharge of concrete. Do

not rapidly raise or lower the tremie to increase the discharge of the concrete. Maintain a continuous flow of concrete and a positive pressure differential of the concrete in the tremie or pump line at all times to prevent water or slurry intrusion into the shaft concrete.

455-15.10 Excavation and Drilling Equipment:

455-15.10.1 General: All shaft excavation is unclassified shaft excavation. The Engineer will require drilled shaft sidewall overreaming when inspections show it to be necessary. These terms are defined in 455-15.10.2, 455-15.10.3, and 455-15.10.4, respectively.

Use excavation and drilling equipment having adequate capacity, including power, torque, and crowd (downthrust), and excavation and overreaming tools of adequate design, size, and strength to perform the work shown in the Plans or described herein. When the material encountered cannot be drilled using conventional earth augers and/or underreaming tools, provide special drilling equipment, including but not limited to rock augers, core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to continue the shaft excavation to the size and depth required. In the event blasting is necessary, obtain all necessary permits. The Contractor is responsible for the effects of blasting on already completed work and adjacent structures. The Engineer must approve all blasting.

455-15.10.2 Unclassified Shaft Excavation: Unclassified shaft excavation is defined as all processes required to excavate a drilled shaft of the dimensions shown in the Contract Documents to the depth indicated in the Plans plus 15 feet or plus 3 shaft diameters, whichever is deeper, completed and accepted. Include in the work all shaft excavation, whether the material encountered is soil, rock, weathered rock, stone, natural or man-made obstructions, or materials of other descriptions.

455-15.10.3 Unclassified Extra Depth Excavation: Unclassified extra depth excavation is defined as all processes required to excavate a drilled shaft of plan dimensions which is deeper than the limits defined as unclassified shaft excavation.

455-15.10.4 Drilled Shaft Sidewall Overreaming: Drilled shaft sidewall overreaming is defined as the unclassified excavation required to roughen its surface or to enlarge the drilled shaft diameter due to softening of the sidewalls or to remove excessive buildup of slurry cake when slurry is used. Increase the shaft radius a minimum of 1/2 inch and a maximum of 3 inches by overreaming. The Contractor may accomplish overreaming with a grooving tool, overreaming bucket, or other approved equipment.

Meet the limit for depth of sidewall overreaming into the shaft sidewall material and the elevation limits between which sidewall overreaming is required.

455-15.11 Inspection of Excavations:

455-15.11.1 Dimensions and Alignment: Provide equipment for checking the dimensions and alignment of each permanent shaft excavation. Determine the dimensions and alignment of the shaft excavation under the observation and direction of the Department. Generally check the alignment and dimensions by any of the following methods as necessary:

1. Check the dimensions and alignment of dry shaft excavations using reference stakes and a plumb bob.
2. Check the dimensions and alignment of casing when inserted in the excavation.
3. Insert a casing in shaft excavations temporarily for alignment and dimension checks.
4. Insert a rigid rod or pipe assembly with several 90 degree offsets equal to the shaft diameter into the shaft excavation for alignment and dimension checks.

Insert any casing, rod or pipe assembly, or other device used to check dimensions and alignment into the excavation to full depth.

455-15.11.2 Depth: Generally reference the depth of the shaft during drilling to appropriate marks on the Kelly bar or other suitable methods. Measure final shaft depths with a suitable weighted tape or other approved methods after final cleaning.

455-15.11.3 Shaft Inspection Device (SID): When shown in the Plans, furnish all power and equipment necessary for the Engineer to inspect the bottom conditions of a drilled shaft excavation and to measure the thickness of bottom sediment or any other debris using a SID. Provide a means to position and lower the SID into the shaft excavation to enable the bell housing to rest vertically on the bottom of the excavation. Include all cost related to the inspection device in the cost of drilled shaft items.

Furnish a SID meeting the following requirements:

1. A remotely operated, high resolution, color video camera sealed inside a watertight bell housing.
2. Provides a clear view of the bottom inspection on a video monitor at the surface in real time.
3. Provides a permanent record of the entire inspection with voice annotation on a quality DVD with a resolution of not less than 720 x 480.
4. Provides a minimum field of vision of 110 square inches, with at least two graduated measuring devices to record the depth of sediment on the bottom of the shaft excavation to a minimum accuracy of 1/2 inch and a length greater than 1-1/2 inches.
5. Provides sufficient lighting to illuminate the entire field of vision at the bottom of the shaft in order for the operator and inspector to clearly see the depth measurement scale on the video monitor and to produce a clear recording of the inspection.
6. Provides a compressed air or gas system to displace drilling fluids from the bell housing and a pressurized water system to assist in determination of bottom sedimentation depth

Obtain the Engineer's approval of the device in advance of the first inspection contingent on satisfactory field performance. Notify the Engineer for approval before a different device is used for any subsequent inspection.

455-15.11.4 Shaft Cleanliness Requirements: Adjust cleaning operations so a minimum of 50% of the bottom of each shaft will have less than 1/2 inches of sediment at the time of placement of the concrete. Ensure the maximum depth of sedimentary deposits or any other debris at any place on the bottom of the shaft excavation does not exceed 1-1/2 inches. The Engineer will determine shaft cleanliness by visual inspection for dry shafts, using divers or an inspection device or other methods the Engineer deems appropriate for wet shafts.

When using slurry, meet the requirements of 455-15.8 at the time of concrete placement.

455-15.11.4.1 Exceptions for Shafts for Sign, Signal, Lighting and ITS Structures: Ensure the depth of sedimentary deposits or other debris does not exceed 1 inch over the bottom of the shaft when installing drilled shafts to support sign, signal, lighting and ITS structures.

455-15.11.5 Time of Excavation: ~~Overream the sidewalls of~~ Any unclassified excavation work using mineral slurry lasting more than 36 hours (measured from the beginning of excavation for all methods except the Temporary or Permanent Casing Method, which begins at the time excavation begins below the casing) before placement of the concrete ~~requires~~

~~overreaming the sidewalls to the depth of softening or removing excessive slurry cake buildup.~~ Ensure that the minimum depth of overreaming the shaft sidewall is 1/2 inches and the maximum depth is 3 inches. Provide any overreaming required at no expense to the Department when exceeding the 36 hour limit unless the time limit is exceeded ~~solely~~ to accomplish excavating deeper than the elevation shown in the Plans as ordered by the Engineer. ~~The Department will pay the Contractor for authorized overreaming resulting from softening or excessive filtercake buildup which is indicated by test methods employed by the Engineer during the initial 36 hour time period.~~ The Department will pay the Contractor for authorized overreaming when excavating deeper than the elevation shown in the Plans as ordered by the Engineer exceeds the 36 hour time limit as Extra Work.

When using mineral slurry, adjust excavation operations so that the maximum time that slurry is in contact with the bottom 5 feet of the shaft (from time of drilling to concreting) does not exceed 12 hours. If exceeding the 12 hour time limit, overream the ~~bottom 5 feet of~~ shaft socket or the full shaft when socket is not specified, at no additional expense to the Department prior to performing other operations in the shaft.

ARTICLE 455-16 is deleted and the following substituted:

455-16 Reinforcing Steel Construction and Placement.

455-16.1 Cage Construction and Placement: Completely assemble and place as a unit the cage of reinforcing steel, consisting of longitudinal bars, ties, and cage stiffener bars, immediately after the Engineer inspects and accepts the shaft excavation and immediately prior to placing concrete. Tie all intersections of drilled shaft reinforcing steel with cross ties or “figure 8” ties. Use double strand ties, ties with larger tie wire, U-bolts, or similar when necessary. The Engineer will give final approval of the cage construction and placement subject to satisfactory performance in the field.

455-16.2 Splicing Cage: If the bottom of the constructed shaft elevation is lower than the bottom of the shaft elevation in the Plans, extend a minimum of one half of the longitudinal bars required in the upper portion of the shaft the additional length. Continue the tie bars for the extra depth, spaced on 2 foot centers, and extend the stiffener bars to the final depth. The Contractor may lap splice these bars or use unspliced bars of the proper length. Do not weld bars to the planned reinforcing steel unless shown in the Contract Documents.

For drilled shafts supporting sign, signal, lighting and ITS structures, if the shaft cleaning operations result in excavating below the required tip elevation, the reinforcing steel cage does not need to be extended. The reinforcing steel cage may be spliced to rest on the bottom of the excavation or suspended in place from the top.

455-16.3 Support, Alignment, and Tolerance: Tie and support the reinforcing steel in the shaft so that the reinforcing steel will remain within allowable tolerances as specified in 455-20 and Section 415.

Use wheels or other approved noncorrosive spacing devices within 3 feet of the bottom, within 6 feet of the top, and intervals not exceeding 10 feet along the shaft to ensure concentric spacing for the entire length of the cage. Do not use block or wire type spacers. Use a minimum of one spacer per 30 inches of circumference of cage with a minimum of four at each level. Provide spacers at the bottom of the drilled shaft reinforcing cage as required to maintain the proper position of the cage.

Check the elevation of the top of the steel cage before and after placing the concrete. If the cage is not within the specified tolerances, correct, and submit a revised DSIP to the Engineer for approval. Do not construct additional shafts until receiving approval from the Engineer.

455-16.4 ~~Cross-Hole Sonic Logging (CSL)~~ Nondestructive Integrity Testing Access

Tubes: Install ~~CSL~~ access tubes full length in all drilled shafts from the tip of shaft to a point high enough above top of shaft to allow ~~T~~Thermal Integrity Testing for Drilled Shafts (TITDS) and ~~C~~cross-Hole S~~sonic L~~ogging (CSL) testing, but not less than 30 inches above the top of the drilled shaft, ground surface or water surface, whichever is higher. Equally space tubes around circumference of drilled shaft. Securely tie access tubes to the inside of the reinforcing cage and align tubes to be parallel to the vertical axis of the center of the cage. Access tubes from the top of the reinforcing cage to the tip of the shaft shall be NPS 1-1/2 Schedule 40 black iron or black steel (not galvanized) pipe. Access tubes above the top of the reinforcing cage may be the same black iron or black steel pipe or Schedule 40 PVC pipe. Ensure that the ~~CSL~~ access tubes are free from loose rust, scale, dirt, paint, oil and other foreign material. Couple tubes as required with threaded couplers, such that inside of tube remains flush. Seal the bottom and top of the tubes with threaded caps. The tubes, joints and bottom caps shall be watertight. Seal the top of the tubes with lubricated, threaded caps sufficient to prevent the intrusion of foreign materials. Stiffen the cage sufficiently to prevent damage or misalignment of access tubes during the lifting and installation of the cage. Exercise care in removing the caps from the top of the tubes after installation so as not to apply excess torque, hammering or other stress which could break the bond between the tubes and the concrete.

Provide the following number (rounded up to the next whole number of tubes) and configuration of cross-hole sonic logging access tubes in each drilled shaft based on the diameter of the shaft.

Shaft Diameter	Number of Tubes Required	Configuration around the inside of Circular Reinforcing Cage
36 to 48 inches	4	90 degrees apart
Greater than 48 inches	1 tube per foot of Shaft Diameter	360 degrees divided by the Number of Tubes

Insert simulated or mock probes in each ~~cross-hole-sonic~~ access tube prior to concreting to ensure the serviceability of the tube. Fill access tubes with clean potable water and recap prior to concreting. Repair or replace any leaking, misaligned or unserviceable tubes as in a manner acceptable to the Engineer prior to concreting.

For drilled shaft foundations requiring anchor bolts, verify ~~CSL~~ access tubes will not interfere with anchor bolt installation before excavating the shaft. When ~~CSL~~ access tube locations conflict with anchor bolt locations, move the ~~CSL~~ access tube location plus or minus 2 inches along the inner circumference of the reinforcing cage. Notify the Engineer before excavating the shaft if the ~~CSL~~ access tube locations cannot be moved out of conflict with anchor bolt locations.

For drilled shafts supporting sign, signal, lighting and ITS structures, if the shaft cleaning operations result in excavating below the required tip elevation, the ~~CSL~~access tubes do not need to be extended. If the reinforcing steel cage is suspended in place from the top rather than resting on the bottom of the excavation, clearly mark the top of shaft location on each tube.

SUBARTICLE 455-17.6 is deleted and the following substituted:

455-17.6 Non-Destructive Testing of Drilled Shaft Integrity:

455-17.6.1 ~~Cross-Hole Sonic Logging (CSL)~~ Thermal Integrity Testing for Drilled Shafts (TITDS): Perform all ~~CSL testing~~ TITDS in accordance with ASTM D~~6760~~7949. Test all drilled shafts in bridge bents or piers considered nonredundant in the Plans, using ~~CSL~~ TITDS. For all other drilled shafts, perform ~~CSL testing~~ TITDS only on drilled shafts selected by the Engineer. The minimum number of shafts tested is the number of shafts indicated in the Plans. The Engineer may increase the number shafts tested as deemed necessary.

Engage a qualified Specialty Engineer to ~~perform~~ supervise the ~~CSL testing~~ TITDS. The qualified ~~CSL~~ TITDS Specialty Engineer must have a minimum ~~three years~~ six months experience of ~~CSL testing~~ TITDS, ~~and~~ have a Florida Licensed Professional Engineer ~~and~~ supervising the collection and interpretation of data. The individual performing the TITDS in the field must work for the Specialty Engineer firm and have a minimum of six months experience of TITDS. The Contractor shall provide all necessary assistance to the ~~CSL~~ TITDS Specialty Engineer to satisfactorily perform the testing.

~~When a shaft contains four tubes, test every possible tube combination. For shafts with five or more tubes, test all pairs of adjacent tubes around the perimeter, and one-half of the remaining number of tube combinations, as chosen by the Engineer.~~

After acceptance of production shafts by the Engineer, remove all water from the access tubes or core holes and fill the tubes or core holes with a structural non-shrink grout meeting the requirements of Section 934 from the bottom via tremie tube. Place the grout utilizing enough pressure to fill the tubes or core holes completely.

If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.

455-17.6.1.1 Equipment: Furnish ~~CSL~~ TITDS test equipment in accordance with ASTM D7949 as follows:

1. ~~Include ultrasonic transmitter and receiver probes for 1.5 inch I.D. pipe which produce measurements with consistent signal strength and arrival time in uniform, good quality concrete with all tube spacings on the project. Provide thermal probes with four orthogonally oriented infrared sensors able to be used in 1.5 inch I.D. pipes.~~

2. ~~Include a microprocessor based data acquisition system for display, storage, and transfer of data. Graphically display first pulse Arrival Time (FAT) during data acquisition. Provide a computer based TITDS data acquisition system for display of signals during data acquisition.~~

3. ~~Electronically measure and record the relative position (depth) of the probes in the tubes with each CSL signal. Provide a depth encoder sensor to determine probe depths.~~

4. ~~Print the CSL logs for report presentation. Provide an air compressor and power supply with sufficient pressure to air lift the water from the access tubes.~~

5. ~~Provide report quality plots of CSL measurements that identify each individual test.~~

6. ~~Electronically store each CSL log in digital format, with shaft identification, date, time and test details, including the transmitter and receiver gain.~~

455-17.6.1.2 Procedure: Perform CSL/TITDS testing between ~~120-24 and 72 hours and 25 calendar days of~~ after shaft concrete placement, unless otherwise directed by the Engineer. Furnish information regarding the shaft, tube lengths and depths, construction dates, and other pertinent shaft installation observations and details to the Department at the time of testing. Verify access tube lengths and their condition in the presence of the Department, at least 24 hours prior to CSL testing/TITDS. If the access tubes do not provide access over the full length of the shaft, repair the existing tube(s) or core additional hole(s), as directed by the Engineer, at no additional cost to the Department.

~~Pull the probes simultaneously, starting from the bottoms of the tubes, over an electronic depth measuring device. Perform the CSL tests with the source and receiver probes in the same horizontal plane. Just prior to inserting the thermal probe, remove water from the access tubes. Store the removed water in an insulated container for later replacement. Allow the thermal probe to acclimate in accordance with the equipment manufacturer recommendations.~~ Continuously record CSL signal/temperatures at depth intervals of 2.5/3.0 inches or less from the ~~bottom/top~~ of the tubes to the top/bottom of each shaft/access tube. ~~Remove all slack from the cables prior to pulling to provide accurate depth measurements in the CSL records.~~ Repeat the test at each access tube until two sets of data from the same access tube provide similar results. Return the warm water to the access tubes immediately after the testing has been completed.

~~Immediately R~~ report any anomalies/potential defects indicated by ~~longer pulse arrival times and significantly lower amplitude/energy signals/temperature anomalies~~ to the Engineer ~~and conduct further tests as required to evaluate the extent of possible defects. Conduct offset CSL measurements between all tube pair combinations in any drilled shafts with 30% or greater in velocity reduction. Record offset measurements with source and receiver vertically offset in the tubes. These measurements add four measurements per tube combination to the horizontal measurements described in this section. Offset measurements are described by the angle (in degrees) and direction the signal travels between the probes with respect to the horizontal plane: plus 45, plus 22.5 (source below receiver), and minus 45, minus 22.5 (source above receiver). Record offset measurements from the point where the higher probe is at least 5 feet below the velocity reduction to the point where the lower probe is at least 5 feet above the velocity reduction. Provide offset CSL logs and 3-D tomographic analysis of all CSL data at no additional cost to the Department in the event 30% or greater in velocity reductions are detected.~~

455-17.6.1.3 Required TITDS Reports: Present the CSL testing/TITDS data and analysis results to the Engineer in a signed and sealed report. ~~Include CSL logs with analyses of first pulse arrival time (FAT) versus depth and pulse energy/amplitude versus depth. Present a CSL log for each tube pair tested with any defect zones identified on the logs and discussed in the test report as appropriate. When offset measurements are required, perform 3-D tomographic analysis using all offset data, and include color coded 3-D tomographic images in~~ The report report shall include as minimum the following items:

1. Graphs displaying all temperature measurements and average temperature versus depth.
2. Indication of unusual temperatures, including cooler local deviations from the average at any depth from the overall average over the entire length.
3. A graph displaying the average temperature and theoretical temperature versus depth.

4. Variations in temperature between access tubes which may indicate variations in cage alignment.
5. The calculated radius of the shaft throughout the entire depth.
6. Alignment of the reinforcing cage along the shaft.
7. Calculated concrete cover throughout the entire depth.
8. A conclusion stating whether the tested shaft is free from integrity defects and meets the minimum concrete cover and diameter requirements by the specifications. When anomalies are detected, include in the report a three dimensional rendering of the shape of the shaft.

455-17.6.1.4 Evaluation of ~~CSL~~TITDS Test Results: The Engineer will evaluate the observations during drilled shaft construction and ~~CSL test~~TITDS results to determine whether or not the drilled shaft construction is acceptable. Drilled shafts ~~with velocity reduction exceeding 30%~~not meeting the minimum cover and diameter requirements, or having integrity defects, are not acceptable without an engineering analysis.

455-17.6.1.5 Coring and/or Repair of Drilled Shafts: If the Engineer determines a drilled shaft is unacceptable based on the ~~CSL~~TITDS tests and ~~tomographic analyses~~other testing, or observes problems during drilled shaft construction, core the shaft to allow further evaluation and repair, or replace the shaft as directed by the Engineer. If coring to allow further evaluation of the shaft and repair is chosen, one or more core samples shall be taken from each unacceptable shaft for full depth of the shaft or to the depth directed by the Engineer. The Engineer will determine the number, location, and diameter of the cores based on the results of ~~3-D tomographic analysis of offset and horizontal CSL data~~the TITDS. Keep an accurate log of cores. Properly mark and place the cores in a crate showing the shaft depth at each interval of core recovery. Transport the cores, along with five copies of the coring log to the location designated by the Engineer. Perform strength testing by an AASHTO certified lab on portions of the cores ~~that exhibit questionable concrete~~ as ~~determined~~required by the Engineer. If the ~~drilled shaft offset CSL~~TITDS testing, 3-D tomographic analyses and coring indicate the shaft is defective, propose remedial measures for approval by the Engineer. Such improvement may consist of, but is not limited to correcting defective portions of the shaft, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. Repair all detected defects and conduct post repair integrity testing using horizontal and offset CSL testing and 3-D tomographic imaging as described in ~~this Section~~455-17.6.2. Engage a Specialty Engineer to perform gamma-gamma density logging to verify the integrity of the shaft outside the reinforcing cage in the same locations ~~offset CSL data~~where the repair was/is required. When straddle shafts or replacement shafts are used to correct a deficient foundation perform TITDS in accordance with 455-17.6.1 through 455-17.6.3 to verify integrity of these shafts. Submit all results to the Engineer within five days of test completion for approval. Perform all work described in this ~~Section~~subarticle at no additional cost to the Department, and with no increase in Contract Time.

455-17.6.2 Access for Thermal Integrity TestingCross Sonic Logging (CSL) and Tomography: ~~Provide safe and secure access and assistance to the Engineer, when requested, for the purpose of evaluating drilled shaft integrity via internal temperature measurements using the Thermal Integrity Test Method as described herein. The Thermal Integrity Test Method is based on measuring the heat generation of hydrating cement. The analysis of measured temperature profiles requires knowledge of the concrete mix used and soil profile for the purposes of determining heat generation and soil insulation parameters. For typical~~

~~drilled shaft concrete mixes, thermal testing should be performed between one and two days after shaft concreting.~~

~~Provide access to the Engineer for testing the shafts within 4 hours of the peak temperature generation, which is expected to occur between 24 hours and 48 hours after shaft concrete placement. Provide access to the Engineer for testing all drilled shafts in bridge bents or piers considered non-redundant in the Plans. Based on the observations during drilled shaft construction, the Engineer may test one or all drilled shafts in bridge bents or piers considered redundant in the Plans. For drilled shaft foundations supporting sign, signal, lighting and ITS structures, only drilled shafts selected by the Engineer will be tested. When required by the Engineer, perform CSL testing in accordance with ASTM D6760. CSL testing may be required when TITDS is not feasible or for any other reason. Engage a qualified Specialty Engineer to perform the CSL testing. The qualified CSL Specialty Engineer must be a Professional Engineer in the State of Florida and have a minimum six months experience of CSL testing, supervising the collection of CSL data and interpretation of CSL results. The individual performing the CLS testing in the field must work for the Specialty Engineer firm and have a minimum of six months experience of CSL testing. The Contractor shall provide all necessary access and assistance to the CSL Specialty Engineer to satisfactorily perform the testing.~~

~~When a shaft contains four tubes, test every possible tube combination. For shafts with five or more tubes, test all pairs of adjacent tubes around the perimeter, and one-half of the remaining number of tube combinations, as chosen by the Engineer. Pull the probes simultaneously, starting from the bottoms of the tubes, over an electronic depth measuring device. Perform the CSL tests with the source and receiver probes in the same horizontal plane. Continuously record temperatures at depth intervals of 2.5-1/2 inches or less from the bottom of the tubes to the top of each shaft. Remove all slack from the cables prior to pulling to provide accurate depth measurements in the CSL records. When the measurements indicate a 30% or greater reduction in velocity between one or more pairs perform 3D tomography analysis as indicated below.~~

~~To perform 3D tomography analysis, conduct offset CSL measurements between the tube pair combinations in addition to the horizontal measurements. Record offset measurements with source and receiver vertically offset in the tubes. These measurements add four measurements per tube combination to the horizontal measurements described in this section. Offset measurements are described by the angle, ~~(in degrees)~~, and direction the signal travels between the probes with respect to the horizontal plane: plus 45, plus 22.5 (source below receiver), and minus 45, minus 22.5 (source above receiver). Record offset measurements from the point where the higher probe is at least 5 feet below the velocity reduction to the point where the lower probe is at least 5 feet above the velocity reduction. When repairs are done, provide offset measurements from the point where the higher probe is at least 5 feet below the lower limit of the repaired zone to the point where the lower probe is at least 5 feet above the upper limit of the repaired zone. Perform offset measurements and provide CSL logs and 3D tomographic analysis at no additional cost to the Department.~~

~~After acceptance of production shafts by the Engineer, fill the tubes or core holes with a structural non-shrink grout in accordance with 455-17.6.1.~~

~~If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.~~

455-17.6.2.1 Required CSL Reports: Present the CSL data and analysis results to the Engineer in a signed and sealed report. Include CSL logs with analyses of first pulse arrival time (FAT) versus depth and pulse energy/amplitude versus depth. Present a CSL log for each tube pair tested with any defect zones identified on the logs and discussed in the test report as appropriate. When offset measurements are required, perform 3D tomographic analysis using all offset data, and include color coded 3D tomographic images in the report.

455-17.6.2.2 Evaluation of Thermal Integrity Cross Hole Sonic logging Testing: The Engineer will evaluate the observations during drilled shaft construction and the Thermal Integrity TCSL test results ~~within three working days of testing the shaft to determine whether or not the drilled shaft construction is acceptable. If the shaft is selected for CSL testing, the evaluation will not be given to the Contractor before all CSL testing and analysis is complete and reported to the Engineer.~~ Drilled shafts with velocity reduction exceeding 30% are not acceptable without an engineering analysis.

455-17.6.2.23 Coring and/or Repair of Drilled Shafts: If the Engineer determines a drilled shaft is unacceptable based on the Thermal Integrity CSL test and other T testing, core the shaft to allow further evaluation and repair, or replace the shaft in accordance with 455-17.6.1.5.

If repairs are performed or additional shafts installed to correct a deficient foundation, conduct integrity testing and submit the results to the Engineer in accordance with 455-17.6.1.5 ~~and when requested, assist the Engineer in retesting the shaft(s) in accordance with 455-17.6.2.~~

ARTICLE 455-18 is deleted and the following substituted:

455-18 Test Hole Method Shafts.

The Engineer will use the construction of ~~test holes method shafts~~ (~~method shafts test holes~~) to determine if the methods and equipment used by the Contractor are sufficient to produce a shaft excavation meeting the requirements of the Contract Documents. During ~~test hole method shaft~~ excavations, the Engineer will evaluate the ability to control dimensions and alignment of excavations within tolerances; to seal the casing into impervious materials; to control the size of the excavation under caving conditions by the use of ~~mineral~~ slurry or by other means; to properly clean the completed shaft excavation; to construct excavations in open water areas; to determine the elevation of ground water; to place reinforcing steel and concrete meeting the requirements of these Specifications within the prescribed time frame; and to execute any other necessary construction operation. Revise the methods and equipment as necessary at any time during the construction of the ~~test hole method shaft~~ when unable to satisfactorily carry out any of the necessary operations described above or when unable to control the dimensions and alignment of the shaft excavation within tolerances.

~~Drill Construct test hole method shafts~~ out of permanent position at the location shown in the Plans or as directed by the Engineer. Ensure the diameter and depth of the ~~test hole method shaft~~ or holes are the same diameter and maximum depth as the production drilled shafts. Reinforce the ~~test hole method shaft~~ unless otherwise directed in the Contract Documents. Fill the ~~test hole method shaft~~ with concrete in the same manner production drilled shafts will be constructed. Backfill ~~test hole method shaft~~ which are not filled with concrete with suitable soil in a manner satisfactory to the Engineer. Leave concreted ~~test hole method shaft~~ in place, except remove the top of the shaft to a depth of 2 feet below the ground line. Use the same procedure

for shafts constructed in water. Restore the disturbed areas at the sites of test-hole method shaft drilled out of position as nearly as practical to their original condition. When the Contractor fails to demonstrate to the Engineer the adequacy of his methods or equipment, and alterations are required, make appropriate modifications and provide additional test holes at no expense to the Department. Include the cost of all test-hole method shaft in the cost of the drilled shafts. Make no changes in methods or equipment after initial approval without the consent of the Engineer.

A separate test-hole method shaft is not required for drilled shafts installed under sign, signal, lighting and ITS structures. The first production shaft will serve as a test-hole method shaft for determining acceptability of the installation method.

SUBARTICLE 455-23.5 is deleted and the following substituted:

455-23.5 Test-Hole Method Shafts: The cost of all test-hole method shafts will be included in the cost of drilled shafts.

SUBARTICLE 455-23.10 is deleted and the following substituted:

455-23.10 Thermal Integrity Testing for Drilled Shafts and Cross-Hole Sonic Logging: The quantity of the cross-hole sonic logging test set-ups TITDS to be paid for will be the number of drilled shafts accepted based on cross-hole sonic logging TITDS tests. When TITDS is not performed in accordance with 455-17.6.1, perform CSL testing at no cost to the Department. No payment will be made for any integrity testing when such testing indicates the shaft cannot be accepted based on the integrity testing itself. No payment will be made for integrity testing performed to evaluate the integrity of post-repair work or for CSL testing not requested by the Engineer. When the Engineer requests CSL tests and the results indicate the shaft is acceptable, the testing will be paid as unforeseen work.

SUBARTICLE 455-24.4 is deleted and the following substituted:

455-24.4 Test-Hole Method Shafts: No separate payment will be made for test hole method shafts (method shaft test holes). All cost of test-hole method shafts will be included in the cost of drilled shafts.

SUBARTICLE 455-24.9 is deleted and the following substituted:

455-24.9 Thermal Integrity Testing for Drilled Shafts and Cross-Hole Sonic Logging: Price and payment will include all costs related to the performance of the TITDS and CSL testing and incidentals to the thermal integrity and cross-hole sonic tests set-up.

SUBARTICLE 455-24.10 is deleted and the following substituted:

455-24.10 Payment Items: Payment will be made under:

Item No. 455- 88- Drilled Shaft - per foot.
Item No. 455-107- Casing - per foot.
Item No. 455-111- Core (Shaft Excavation) - per foot.
Item No. 455-119- Test Loads - each.
Item No. 455-122- Unclassified Shaft Excavation - per foot.
Item No. 455-129- Instrumentation and Data Collection - lump sum.
~~Item No. 455-142- Cross Hole Sonic Logging - each.~~
Item No. 455-147- Thermal Integrity Testing for Drilled Shafts - each