SECTION 331636 - GROUND-LEVEL REINFORCED CONCRETE WATER STORAGE TANKS

This Section specifies design, fabrication, and erection of precast, prestressed, concrete water storage tanks. This Section places responsibility for design on Contractor, because specialized design expertise is not usually found within most consultant engineering firms. Edit this Section accordingly.

1. GENERAL
   * + 1. SUMMARY
          1. Section Includes: Precast, prestressed, concrete water storage tank for ground-level installation.
          2. Related Requirements:

List other Sections directly related to or affecting Work of this Section. Include Sections specifying information expected to be found in this Section as well as Sections required to describe complete system or assembly requirements.

Section 033713 - Shotcrete: Requirements for pneumatically applied concrete.

Section 099723.24 - Concrete Water Storage Tank Painting: Preparing and painting of concrete water storage tanks for potable water use.

Section 310000 – Earthwork: Excavation, backfilling, and bedding requirements for water tank.

Section 310001 – Earthwork Materials: backfill and bedding material for water tank.

Section 330110.58 - Disinfection of Water Utility Storage Tanks: Flushing and disinfecting of water tank.

Section 331413 - Public Water Utility Distribution Piping: Connection to water distribution system.

Section 331416 - Site Water Utility Distribution Piping: Connection to water distribution system.

* + - 1. REFERENCE STANDARDS

List reference standards included within text of this Section, with designations, numbers, and complete document titles.

* + - * 1. American Concrete Institute:

ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

ACI 305R - Guide to Hot Weather Concreting.

ACI 305.1 - Specification for Hot Weather Concreting.

ACI 306R - Guide to Cold Weather Concreting.

ACI 306.1 - Standard Specification for Cold Weather Concreting.

ACI 309R - Guide for Consolidation of Concrete.

ACI 318 - Building Code Requirements for Structural Concrete.

ACI 347R - Guide to Formwork for Concrete.

ACI 372R - Guide to Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.

* + - * 1. American Society for Civil Engineers:

ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

* + - * 1. ASTM International:

ASTM A615Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

ASTM A821 - Standard Specification for Steel Wire, Hard-Drawn for Prestressed Concrete Tanks.

ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

ASTM C33 - Standard Specification for Concrete Aggregates.

ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

ASTM C94 - Standard Specification for Ready-Mixed Concrete.

ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.

ASTM C150 - Standard Specification for Portland Cement.

ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.

ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

* + - * 1. American Water Works Association:

AWWA C110 - Ductile-Iron and Gray-Iron Fittings.

AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

AWWA C115 - Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.

AWWA C150 - Thickness Design of Ductile-Iron Pipe.

* + - * 1. American Welding Society:

AWS D1.4 - Structural Welding Code - Reinforcing Steel.

* + - * 1. Concrete Reinforcing Steel Institute:

CRSI - Manual of Standard Practice.

* + - * 1. NSF International:

NSF 61 - Drinking Water System Components - Health Effects.

NSF 372 - Drinking Water System Components - Lead Content.

* + - * 1. Society for Protective Coatings:

SSPC-SP 10 - Near-White Metal Blast Cleaning.

* + - * 1. U.S. Army Corps of Engineers:

CRD-C572 - Handbook of Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop.

* + - 1. COORDINATION
         1. Coordinate Work of this Section with connection to water distribution system.
      2. PREINSTALLATION MEETINGS
         1. Convene with the Director’s Representative a minimum [**one week**] [**<\_\_\_\_\_\_\_\_> weeks**] prior to commencing Work of this Section.
      3. SUBMITTALS

Only request submittals needed to verify compliance with Project requirements.

* + - * 1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
        2. Manufacturer’s installation instructions shall be provided along with product data.
        3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
        4. Product Data:

Submit manufacturer's product literature, including catalog information, dimensions, materials, instructions for installation and use, and application rates for following:

Waterstop.

Joint filler.

Bond breaker.

Curing compound.

Vibration equipment.

Bearing pads.

Joint sealant.

Roof hatch.

Roof ventilator.

Ladders and railings.

Wall manhole.

Piping.

Couplings.

<**\_\_\_\_\_\_\_\_**>.

USE PARAGRAPH BELOW WITH EPD REQUIREMENT WHEN PROJECT ESTIMATE IS $1M OR MORE.

* + - * 1. Submit an Environmental Product Declaration (EPD) from the manufacturer for each type of precast structure within this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

* + - * 1. Shop Drawings:

Indicate details of reinforcing steel, prestress tendons, joint design, concrete mix design, and openings in wall diaphragm.

Indicate reinforcing steel identification marks for each bar.

Indicate precast concrete unit identification marks for each unit.

* + - * 1. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
        2. Submit concrete batch tickets, according to ASTM C94, with following information:

Type, name, and quantity of admixtures.

Type, brand, and quantity of cement.

Total water content by producer.

Maximum size of aggregate.

Weights of fine and coarse aggregate.

* + - * 1. Welders' Certificates: Certify welders and welding procedures employed on the Work, verifying AWS qualification within previous 12 months.

Include separate paragraphs for additional certifications.

Include following paragraph when Contractor is responsible for designing products or assemblies. List affected products when Section specifies more than one product.

* + - * 1. Delegated Design Submittals: Submit Shop Drawings with design calculations and assumptions for tank and tank foundation. All Shop Drawings shall be signed and sealed by a licensed engineer in the State of New York.
        2. Source Quality-Control Submittals: Indicate results of [**shop**] [**factory**] tests and inspections.
        3. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
        4. Manufacturer Reports: Certify that foundation and tank have been installed according to manufacturer instructions.
        5. Qualifications Statements:

Coordinate following subparagraphs with requirements specified in QUALIFICATIONS Article.

Submit qualifications for manufacturer, installer, and licensed professional.

Submit manufacturer's approval of installer.

Remove paragraph if not LEED project.

* + - 1. SUSTAINABLE DESIGN SUBMITTALS
         1. Section 018113 - LEED Documentation Requirements: Requirements for sustainable design submittals.
         2. Manufacturer's Certificate:

Certify that products meet or exceed specified sustainable design requirements.

Materials Resources Certificates:

Certify source and origin for [**salvaged**] [**and**] [**reused**] products.

Certify recycled material content for recycled content products.

Certify source for regional materials and distance from Project Site.

* + - * 1. Product Cost Data:

Submit cost of products to verify compliance with Project sustainable design requirements.

Exclude cost of labor and equipment to install products.

Provide cost data for following products:

Edit list of material cost data below to suit products specified in this Section and Project sustainable design requirements. Specific cost data requirements are specified in Section 018113.

Salvaged, refurbished, and reused products.

Products with recycled material content.

Regional products.

<**\_\_\_\_\_\_\_\_**>.

* + - 1. CLOSEOUT SUBMITTALS
         1. Section 017716 - Contract Closeout: Requirements for submittals.
         2. Project Record Documents: Record actual location, layout, and final configuration of water storage tanks.
      2. MAINTENANCE MATERIAL SUBMITTALS
         1. Extra Stock Materials: Furnish [**two**] <**\_\_\_\_\_\_\_\_**> safety harnesses for ladder safety rail system.
      3. QUALITY ASSURANCE

Include this Article to specify compliance with overall reference standards affecting products and installation included in this Section.

* + - * 1. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.
        2. Perform Work according to [**NYSDOH**] [**AWWA**]<**\_\_\_\_\_\_\_\_**> standards.

Include following paragraph only when cost of acquiring specified standards is justified.

* + - * 1. Maintain <**\_\_\_\_\_\_\_\_**> [**copy**] [**copies**] of each standard affecting Work of this Section on Site.
      1. QUALIFICATIONS

Coordinate following paragraphs with requirements specified in SUBMITTALS Article.

* + - * 1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum [**three**] <**\_\_\_\_\_\_\_\_**> years' [**documented**] experience.
        2. Installer: Company specializing in performing Work of this Section with minimum [**three**] <**\_\_\_\_\_\_\_\_**> years' [**documented**] experience [**and approved by manufacturer**].
        3. Welders: AWS qualified within previous 12 months for employed weld types.
        4. Licensed Professional: [**Professional Engineer**] <**\_\_\_\_\_\_\_\_**> experienced in design of specified Work and licensed [**in the State of New York**].
      1. DELIVERY, STORAGE, AND HANDLING
         1. Section 016500 - Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.
         2. Precast Units:

Transport and handle units with equipment designed to protect units from damage.

Do not place units in positions capable of causing overstress, warping, or twisting.

Separate stacked units with battens across full width of each bearing point.

Stack units with lifting devices, ensuring that they are accessible and undamaged and identification marks are discernible.

* + - * 1. Reinforcing Steel:

For reinforcing steel fabricated on Site, ship from mill in bundles limited to one size and length and identified with waterproof tag, showing name of mill, heat number, grade and size of bars, and identifying number.

For reinforcing steel fabricated off Site:

Deliver in bundles identified by structure and Shop Drawing number.

Identify each individual bar with waterproof tag, showing grade, size, and bar mark from Shop Drawings.

Protect reinforcing steel and wire fabric from damage, dirt, oil, grease, other foreign matter, and rust-causing conditions.

Do not store reinforcement in direct contact with ground.

* + - * 1. Concrete Ingredients: Handle, control, and store concrete materials according to ACI 304R.
        2. Ductile-Iron Pipe:

Exercise care to prevent damage to piping materials during loading, transporting, unloading, and storage on Site.

Do not drop pipe or fittings.

Store materials on Site in enclosures or under protective coverings.

Keep materials clean and dry.

Do not store materials directly on ground.

* + - 1. EXISTING CONDITIONS
         1. Field Measurements:

Verify field measurements prior to fabrication.

Indicate field measurements on Shop Drawings.

1. PRODUCTS
   * + 1. PERFORMANCE AND DESIGN CRITERIA

ASTM E96 permits testing using desiccant and water methods. Samples may be tested with one surface wetted if using water method. Samples may be tested with low humidity on one side and high humidity on opposite side. Single material tested using variable conditions will produce variable test results.

Select test method and service conditions as required to suit application.

* + - * 1. Vapor Retarder Permeance:

Maximum: [1] <\_\_\_\_\_\_\_\_> perm.

Testing: Comply with ASTM E96 [**, using desiccant method**] [**, using water method**].

* + - * 1. Design Criteria:

Tank Design: Comply with ACI 372R.

Horizontal Prestressing:

Type: Continuous.

Discontinuous prestressing tendons are not permitted.

Design Loads:

Dead Load: Estimated weight of permanent construction and fittings.

Live Load: Weight of liquid when tank is filled to overflowing.

Roof Live Load for Dome Roof: Minimum <\_\_\_\_\_\_\_\_> psf, unless otherwise allowed by ASCE 7.

Snow Load: As required by ASCE 7.

Backfill Pressure:

Determine earth loads by rational methods of soil mechanics.

Do not use backfill pressure to reduce prestressing required.

Foundation Loads: Proportion foundation to produce soil pressure of less than soil bearing capacity.

Allowable Soil Bearing Capacity: <\_\_\_\_\_\_\_\_> psf.

Seismic Loads: As required by ASCE 7.

Wind Loads: As required by ASCE 7.

Hand Railings: Withstand <\_\_\_\_\_\_\_\_> lb. applied in any direction on top rail with no permanent set, cracking, or failure of welds.

Prestressed Tank Wall:

Design as composite concrete wall with embedded mechanically bonded steel diaphragm in combination with vertical mild steel reinforcement.

Consider prestressed tank wall cylindrical shell with partial edge restraint.

Vertical Reinforcing:

Reinforce prestressed tank wall vertically by deformed steel reinforcing rods and welded wire fabric.

Continuous mechanically bonded steel diaphragm can be taken as effective vertical reinforcing.

Prestressed Tank Wall Construction:

Material: Precast concrete.

Shotcrete or cast-in-place concrete core walls are not permitted.

Minimum core wall thickness: 4 inches.

Do not reduce ring compression or tension in wall due to restraint at bottom of wall.

Floor Slab: Design as membrane floor not less than <\_\_\_\_\_\_\_\_> inches thick, placed monolithically without construction joints.

Wall Footings: Above or below floor grade, placed monolithically with floor.

Dome Roof:

Base design on elastic spherical shell analysis.

Rise-to-Span Ratio: Within range of 1:8 to 1:14.

Minimum Precast Dome Panel Thickness: <\_\_\_\_\_\_\_\_> inches.

Dome Support: Fixed to tank wall without columns or interior supports.

* + - 1. CONCRETE WATER STORAGE TANK
         1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=8771&mf=04&src=wd):

DN Tanks, (781) 246-1133, 11 Teal Rd., Wakefield, MA 01880.

Approved equivalent.

* + - 1. DUCTILE-IRON PIPE
         1. Pipe:

Comply with AWWA C150.

End Connections:

Yard Piping:

Mechanical or push-on joints.

Comply with AWWA C111.

Interior Piping:

Flanged joints.

Comply with AWWA C115.

* + - * 1. Fittings:

Comply with AWWA C110.

Material: [**Ductile iron**] [**or**] [**cast iron**].

* + - * 1. Interior Coatings:

Description: Approved by EPA for contact with potable water.

Coatings:

Description: Two coats of high-build epoxy.

Minimum Dry Film Thickness: 4.0 mils.

* + - * 1. Exterior Coatings:

Preparation: Sandblast exterior of piping to SSPC-SP 10 prior to application of shop coating.

Coatings:

Piping Outside Tank: Manufacturer's standard asphaltic coating.

Other Piping:

Primer: Zinc-rich primer or epoxy primer compatible with finish coat; minimum 3.0-mil dry film thickness.

Finish: As specified in Section [**099723.24 - Concrete Water Storage Tank Painting**] <**\_\_\_\_\_\_-\_\_\_\_\_\_\_\_\_\_\_\_**>.

Remove paragraph if not LEED project.

* + - 1. SUSTAINABILITY CHARACTERISTICS

Insert sustainable design characteristics in this Article to suit content of this Section and Project sustainable design requirements as specified in Section 018113.

* + - * 1. Section 018113 – LEED Documentation Requirements: Requirements for sustainable design compliance.
        2. Material and Resource Characteristics:

Recycled Content Materials: Furnish materials with maximum available recycled content [**including:**] [**.**]

Insert list of materials specified in this Section required to have recycled content.

<**\_\_\_\_\_\_\_\_**>.

Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles of Project Site [**including:**] [**.**]

Insert list of materials specified in this Section required to be regional materials.

<**\_\_\_\_\_\_\_\_**>.

* + - 1. MATERIALS
         1. Concrete:

Portland Cement: Comply with ASTM C150, Types I, IA, or II.

Fine Aggregate:

Comply with ASTM C33.

Maximum Aggregate Size: <\_\_\_\_\_\_\_\_> inches.

Washed natural sand.

Weighted percentage of loss not more than 12 percent by weight when subjected to five cycles of magnesium sulfate soundness test according to ASTM C88.

Coarse Aggregate:

Comply with ASTM C33.

Maximum Aggregate Size: <\_\_\_\_\_\_\_\_> inches.

Percentage of wear not exceeding 45 percent when tested according to ASTM C535.

Weighted percentage of loss not more than 15 percent by weight when subjected to five cycles of magnesium sulfate soundness test according to ASTM C88.

Water: Potable.

Admixtures:

Air Entraining Admixture: Comply with ASTM C260.

Other Admixtures: Comply with ASTM C94.

Admixtures containing calcium chloride or soluble chlorides are not permitted.

Maximum Free Chloride Ions: 0.06 percent of weight of cement in concrete mix.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Concrete: As specified in Section 033000 – Cast-in-Place Concrete.
        2. Shotcrete: As specified in Section 033713 - Shotcrete.
        3. Reinforcement:

Reinforcing Steel:

Accurately formed.

Free of loose rust, scale, and contaminants capable of reducing bond.

* + - * 1. Non-prestressed Reinforcement:

Reinforcing Steel Bars:

Comply with ASTM A615.

Grade: [**40**] [**60**].

[**As indicated on Drawings.**]

Welded Steel Wire Fabric: Comply with ASTM A1064.

* + - * 1. Prestressed Reinforcement:

Comply with ASTM A821.

Wire:

Type: Cold drawn, high carbon.

Minimum Ultimate Tensile Strength: <\_\_\_\_\_\_\_\_> psi.

Splices: Ferrous material compatible with reinforcement and capable of developing full strength of reinforcement.

Splice and Anchorage Accessories: Type that will not nick or otherwise damage reinforcement.

* + - * 1. Steel Diaphragms:

Comply with ASTM A1008.

Minimum Thickness: 26 gage.

Configuration:

Vertically ribbed with reentrant angles.

Form with back of channels wider than front, providing mechanical keyway anchorage with concrete and shotcrete encasement.

* + - 1. ACCESSORIES
         1. Waterstops:

Material: PVC.

Comply with CRD-C572.

Shape: As indicated on Drawings.

Type: Suitable for heat-welded joints.

Size: [**As indicated on Drawings**] [**<\_\_\_\_\_\_\_\_>-inch minimum width**].

* + - * 1. Bearing Pads:

Neoprene: Comply with ASTM D2000.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Natural Rubber:

Raw Polymer: Only virgin natural polyisoprene.

Comply with ASTM D2000.

* + - * 1. Joint Filler:

Material: [**Closed cell neoprene**] [**or**] [**rubber**].

Comply with ASTM D1056, Type 2, Class D, Grade 5.

Compression Deflection: Maximum 25 percent at <\_\_\_\_\_\_\_\_> to <\_\_\_\_\_\_\_\_> psi.

* + - * 1. Joint Sealant:

Description: Polysulfide, two-component elastomeric compound with permanent characteristics of bond to metal surfaces, flexibility, and resistance to extrusion due to hydrostatic pressure.

Air-cured sealants are not permitted.

* + - * 1. Spacers, Chairs, Bolsters, Ties, and Other Devices:

Material: [**Galvanized steel**] [**or**] [**non-corroding material**].

Comply with CRSI Manual of Standard Practice.

ASTM C309 Type and Class are as follows:

- Type 1 - Clear or translucent without dye.

- Type 1D - Clear or translucent with dye.

- Type 2 - White pigmented.

- Class A - No restrictions on vehicle solids material.

- Class B - Vehicle solids restricted to all resin material.

* + - * 1. Curing Compound:

Comply with ASTM C309, Type [**1**] [**1D**] [**2**], Class [**A**] [**B**].

Type: Membrane forming.

Use Type 2 if curing temperature is expected to be greater than <\_\_\_\_\_\_\_\_> degrees F during first three days of curing.

Use only Type l or Type 2 curing compounds for entire structure; do not use both Type 1 and Type 2 on single structure.

Curing Compounds Used Inside Tank: Approved by EPA for contact with potable water.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

ASTM C1315 Type and Class are as follows:

- Type I - Clear or translucent.

- Type II - White pigmented.

- Class A - Non-yellowing.

- Class B - Moderate yellowing.

- Class C - Unrestricted color change permitted.

* + - * 1. Membrane Curing Compound: Comply with ASTM C1315, Type [**I**] [**II**], Class [**A**] [**B**] [**C**].
        2. Vapor Retarder:

Material: PE.

Thickness: 6 mils.

* + - * 1. Flexible Pipe Couplings:

Description: Factory pre-assembled couplings for plain-end pipe.

Type: Double ring, wedge gasketed, flared sleeve.

End Connections: Mechanical joint.

Comply with AWWA C111.

* + - * 1. Tank Accessories:

Roof Hatch:

Size: [**Minimum <\_\_\_\_\_\_\_\_> by <\_\_\_\_\_\_\_\_> feet**] [**As indicated on Drawings**].

Closure: Locking hasp and bronze cylinder lock.

Roof Ventilator:

Fiberglass vent with aluminum or bronze insert screen.

Minimum Diameter: <\_\_\_\_\_\_\_\_> feet.

Access:

Comply with OSHA standards.

Outside Ladder:

Material: Aluminum.

Removable First Section: <\_\_\_\_\_\_\_\_> feet from ground level.

Remainder of Ladder: Provide safety cage, hinged entrance cover, hasp, and bronze cylinder lock.

Ladder Grab Extension: <\_\_\_\_\_\_\_\_> feet above roof.

Roof Handrail:

Material: Aluminum.

Height: <\_\_\_\_\_\_\_\_> feet where indicated on Drawings.

Safety Rail: Provide along entire ladder length and extending <\_\_\_\_\_\_\_\_> feet above tank roof.

Wall Manholes:

Quantity: Two.

Opening Size: [**<\_\_\_\_\_\_\_\_> by <\_\_\_\_\_\_\_\_> feet**] [**As indicated on Drawings**].

Material: Carbon steel.

Furnish hinged covers located as indicated on Drawings.

Minimum Pressure Rating: <\_\_\_\_\_\_\_\_> psi.

* + - 1. SOURCE QUALITY CONTROL
         1. Concrete Testing:

State to provide independent third party testing agency for all concrete testing. Sampling and testing shall be completed as follows.

Compressive Strength, Slump, and Air Content Tests:

Perform for each <\_\_\_\_\_\_\_\_> cu. yd. of concrete placed or any portion thereof.

Cast [**three**] <**\_\_\_\_\_\_\_\_**> cylindrical strength test specimens for each test set.

Test Age:

Test two cylinders at seven days.

Test two cylinders at 28 days.

Hold remaining cylinder for testing if other cylinders are damaged prior to testing.

Determine concrete strength from standard test specimens made and cured according to ASTM C31 and ASTM C172, and tested according to ASTM C39.

Core Drilling and Testing:

Perform according to ASTM C42 in locations as directed by the Director’s Representative.

Compute and evaluate according to ASTM C94.

Air Content: Comply with ASTM C231 or C173, as applicable.

Slump: Comply with ASTM C143.

1. EXECUTION
   * + 1. EXAMINATION
          1. Verify that elevations and grading for water storage tank and location of water storage tank are as indicated on Drawings.
       2. INSTALLATION
          1. Excavation and Backfill:

As specified in Section 310000 - Earthwork.

If groundwater is encountered, prevent accumulation of water in excavations.

Set precast structures bearing firmly and fully on crushed stone bedding, compacted as specified in Section [**310000 - Earthwork**] or on other support system as indicated on Drawings.

* + - * 1. Concrete:

Unless otherwise specified, comply with ACI 304R, 305R, 305.1, 306R, and 306.1 for concrete installation requirements, such as preparing, mixing, conveying, depositing, curing, and cold and hot weather requirements.

Consolidate concrete according to ACI 309R.

Discharge concrete within 90 minutes or 300 revolutions, whichever occurs first, after first mixing of cement and aggregates.

* + - * 1. Shotcrete: As specified in Section 033713 - Shotcrete.
        2. Reinforcement:

Non-prestressed:

Cleaning and Bending: Clean metal reinforcement free of loose rust, mill scale, or other coatings capable of reducing bond.

Cutting and Bending:

Perform cutting and bending in shop.

Bend and cut steel cold; do not bend or straighten bars in manner capable of injuring material.

Placement:

Arrange and place reinforcement as indicated on Shop Drawings.

Secure into position with chairs, spacers, and ties.

Concrete brick may be used to support reinforcement for slabs on grade if approved by Director’s Representative.

Splicing:

Furnish reinforcing bars in full lengths as indicated on [**Shop**] Drawings.

Do not splice bars unless indicated on [**Shop**] Drawings.

Make splices according to ACI 318 and perform welding according to AWS D1.4.

Lap mesh reinforcement minimum one mesh space plus <\_\_\_\_\_\_\_\_> inch, and tie.

Concrete Cover:

Provide clearance and spacing as indicated on Drawings.

If no clearances are indicated, provide minimum <\_\_\_\_\_\_\_\_>-inch thickness of concrete cover over reinforcement.

Prestressed:

Placement:

Place prestressing wire on wall with wire-winding machine capable of consistently producing stress in wire within range of zero to 7 percent of stress required by design.

Circumferential movement of wire along tank wall is not permitted during or after stressing wire.

Stress wire by drawing wire through die or by other means resulting in uninterrupted elongation, ensuring uniform stress throughout its length and over periphery of tank.

Temporarily anchor each coil of prestressing wire at sufficient intervals to minimize loss of prestress if wire breaks during wrapping.

Spacing:

Minimum Spacing (Center-to-Center) of Prestressing Wires: <\_\_\_\_\_\_\_\_> inch.

Minimum Clear Space between Wires: <\_\_\_\_\_\_\_\_> inch or l.5 wire diameters, whichever is greater.

Adjust wires not meeting spacing requirements.

Do not place prestressing closer than <\_\_\_\_\_\_\_\_> inch from top of wall, edges of openings, or inserts, or closer than <\_\_\_\_\_\_\_\_> inch from base of walls or floors where radial movement may occur.

Displace band of prestressing normally required over height of an opening into circumferential bands immediately above and below the opening to maintain required prestressing force.

Do not bundle wires.

Splicing: Join ends of individual coils with suitable steel-splicing devices capable of developing full strength of wire.

Stress Recording:

Furnish calibrated stress recording device that can be recalibrated to determine wire stress levels on wall during and after prestressing process.

Take at least one stress reading for every <\_\_\_\_\_\_\_\_> feet or for every roll of wire, whichever is greater, immediately after wire has been applied on wall.

Take stress readings on straight lengths of wire.

Record stress readings and identify height and layer of wire for each reading.

Keep written record of stress readings.

When applied stresses fall below design stress in steel, provide additional wire to bring stress up to required design stress.

When stress in steel is more than 7 percent over required design stress, discontinue and adjust wrapping operation.

* + - * 1. Formwork:

Responsibility: Design and construction of formwork is sole responsibility of Contractor.

Design Criteria:

Design formwork system with adequate bracing, strength, and stability to ensure finished concrete is within tolerances according to ACI 347R.

Ensure that formwork is sufficiently tight to prevent leakage of mortar.

Chamfer external corners <\_\_\_\_\_\_\_\_> inch.

Coating Forms:

Coat forms with bond breaker before placing reinforcing steel.

Do not allow excess form coating material to stand in puddles in forms or to come into contact with concrete against which fresh concrete is to be placed.

Clean reinforcing steel contaminated with bond breaker before placing concrete.

Embedded Items:

Clean items to be embedded in concrete to be free of oil or foreign matter capable of reducing bonding of concrete to embedded items.

Install inserts, anchors, sleeves, and other items specified under other Sections.

Close with caps or plugs ends of conduits, piping, and sleeves embedded in concrete.

Waterstops:

Install waterstops according to manufacturer instructions.

Support and protect portion of waterstop extending beyond bulkhead during placement of concrete and subsequent removal of forms.

Heat Sealing:

Heat-seal field splices to make watertight.

Maintain continuity of ribs and bulbs.

Allow splice to cool before stressing reinforcement.

Repair damaged waterstops before placing concrete. Coordinate repairs with Director’s Representative.

* + - * 1. Mixing:

Ready-Mixed Concrete: Comply with ASTM C94.

Do not over-mix concrete or use concrete retained in mixers for duration that requires additional water in excess of design mix water to permit satisfactory placement.

Use preparation methods capable of producing concrete with temperature of not more than <\_\_\_\_\_\_\_\_> degrees F and not less than <\_\_\_\_\_\_\_\_> degrees F when placed.

Do not heat concrete ingredients to temperature higher than necessary to keep temperature of mixed concrete, as placed, within specified temperatures.

Do not heat water in excess of <\_\_\_\_\_\_\_\_> degrees F.

* + - * 1. Conveying: Use methods that prevent segregation or loss of materials.
        2. Concrete Placement:

Deposit concrete as near as practical into its final position to avoid segregation due to rehandling or flowing.

Do not use vibrators to move concrete horizontally within forms.

Do not use retempered concrete or concrete contaminated by foreign material.

Plan and conduct concrete placement to ensure concrete is kept plastic and free of cold joints.

When continuous installation is delayed more than 45 minutes between adjacent concrete placements, install bulkhead construction joint, complete with waterstops where required.

Remove temporary spreaders in forms if concrete has reached elevation making spreaders unnecessary.

Do not commence placement when sun, heat, wind, or limitations of facilities prevent proper finishing or curing.

Discontinue concreting when descending ambient air temperature falls lower than <\_\_\_\_\_\_\_\_> degrees F, unless preparations are made and in place to heat or insulate concrete according to cold weather concreting requirements.

* + - * 1. Consolidation:

Consolidate concrete thoroughly, as it is placed to secure dense mass.

Work concrete well around reinforcement and embedded items and into corners of forms.

Use internal vibrators inserted vertically over entire area.

Vibrate until voids are eliminated, coarse aggregate is suspended in mortar, and entrapped air bubbles begin to rise to surface; concrete should move back into space vacated by vibrator.

Space vibrator insertions such that area visibly affected by vibrator overlaps adjacent just-vibrated area by [**several**] <\_\_\_\_\_\_\_\_> inches.

Penetrate at least <\_\_\_\_\_\_\_\_> inches into previously placed layers to bond between layers and avoid cold joints.

Vibrators:

Do not use form vibrators.

Do not over-vibrate air entrained concrete.

Place vibrator to eliminate honeycombing but avoid excess vibrating that bleeds entrapped air from mix.

Do not use vibrators to transport concrete.

* + - * 1. Concrete Protection:

Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

Maintain concrete with minimum moisture loss and relatively constant temperature for period as necessary for hydration of cement and hardening of concrete.

After concrete has hardened, loosen forms as soon as possible without damaging concrete and run curing water continuously down inside of form.

* + - * 1. Removal of Forms:

Do not remove forms until members have acquired sufficient strength to safely support their own weight and imposed loads.

In cold weather, retain forms in place for five days.

Notify Director’s Representative before forms are removed such that newly stripped surfaces may be examined prior to patching.

* + - * 1. Repair of Tie Holes and Minor Defects:

Make necessary repairs immediately after form removal.

Honeycombs and Small Defective Areas:

Remove to sound concrete.

Wet affected area.

Brush on bonding grout consisting of one part cement, one part fine sand, and water to produce consistency of thick cream.

Apply patching mortar consisting of one part cement, two-and-one-half parts sand, and sufficient water to produce stiff consistency.

Consolidate patching mortar and strike off to leave patch slightly higher than surrounding surface.

Finish repaired area flush with surrounding area after mortar has been in place for one hour.

Tie Holes:

Thoroughly clean and dampen.

Fill solid with patching mortar.

Perform patching before curing compound is applied.

Cure patched areas same as adjacent concrete.

Make repairs uniform in color and finish as surrounding concrete.

* + - * 1. Curing:

Keep concrete moist for at least seven curing days after placement; curing day is defined as a 24-hour time period during which concrete surfaces are kept moist and uniform temperature of concrete mass is maintained between <\_\_\_\_\_\_\_\_> and <\_\_\_\_\_\_\_\_> degrees F.

Water Curing:

Preferred method of protection.

Cover exposed surfaces with saturated burlap or cotton mats and keep wet continuously with soil soaker hose for seven days.

Leave covering in place without wetting for additional three days.

Curing Compound:

Do not use curing compounds on surfaces to which mortar, concrete, or paint is applied.

Keep surfaces moist after forms are removed and form tie holes are repaired.

After surfaces are finished, apply curing compound according to manufacturer instructions.

Slabs: Immediately following slab finishing, apply liquid membrane forming curing compound or begin water curing before surface becomes dry.

* + - * 1. Floor and Wall Footings:

Construct floor and wall footings to dimensions as indicated on Drawings.

Place vapor retarder over subbase, overlapping joints minimum of <\_\_\_\_\_\_\_\_> inches.

Install inlet, outlet, drain pipes, overflow pipes, and other penetrations through floor and encase in concrete.

Vertical Waterstop:

Install and support such that bottom of center bulb is at elevation of top of footing.

Support waterstop without puncturing it.

Splice waterstop using thermostatically controlled sealing iron.

Spark-test each splice before encasement in concrete.

Install floor and wall footings monolithically; construction joints in floor or between floor and footings are not permitted.

Cure floor by flooding with water and maintaining saturated for seven days.

Finish floor slab with mechanical steel float.

* + - * 1. Precast Wall and Dome:

Precast Wall:

Construct with continuous waterproof steel diaphragm embedded in exterior of precast panel.

Horizontal joints in diaphragm are not permitted.

Holes, form ties, nails, or other punctures are not permitted.

Temporary wall openings may be provided for access and removal of construction materials from tank interior, subject to approval of Director’s Representative.

Locate wall and dome panel beds around periphery of tank as required.

Construct beds to provide finished panels with proper curvature of tank.

Place PE sheeting between successive pours to provide high-moisture environment and long, slow cure for concrete.

Furnish equipment capable of lifting wall and dome panels and placing them in their proper location without causing damage to or excessive bending of panels.

Tolerances:

Erect precast panels to correct vertical and circumferential alignment.

Edges of Adjoining Panels: <\_\_\_\_\_\_\_\_>-inch maximum inward or outward variation.

Tank Radius: <\_\_\_\_\_\_\_\_>-inch maximum variation.

Panel Finish:

Light Broom Finish for Following Surfaces:

Interior of precast wall panels.

Exterior of precast dome panels.

Dome slots.

* + - * 1. Hot Weather Requirements:

If temperature in forms is <\_\_\_\_\_\_\_\_> degrees F or above, or combination of high air temperature, low relative humidity, and wind velocity impair quality of fresh or hardened concrete, take protective measures for mixing, transporting, and placing concrete according to ACI 305R and 305.1.

Place concrete at temperature of not more than <\_\_\_\_\_\_\_\_> degrees F at point of placement.

When ice is used to lower temperature, place crushed, shaved, or chipped ice directly into mixer as part of mixing water, and mix until ice is completely melted.

Record concrete temperature at time of discharge.

Adding Water:

Do not add excess water causing mix to exceed maximum water-cementitious materials ratio of 0.43.

Notify Director’s Representative before adding water to concrete mix.

Record quantity of water added to concrete at Site.

Discharge concrete within 45 minutes or 100 revolutions, whichever occurs first, after first mixing of cement and aggregates.

Placing and Curing:

Place concrete promptly upon arrival at Site.

Provide at least one standby vibrator for each three vibrators in use.

Protect concrete from direct sunlight.

Keep forms covered and moist by water sprinkling or application of continuously wetted burlap or cotton mats for minimum of 24 hours.

When forms are removed, provide wet cover to newly exposed surfaces to avoid exposure to sun and wind.

Continue specified water-curing methods for 10 days and leave covering in place four additional days.

Alternate wetting and drying cycles are not permitted.

* + - * 1. Cold Weather Requirements:

If daily temperature is <\_\_\_\_\_\_\_\_> degrees F or lower during placement and protection period, protect concrete surfaces from freezing for at least 24 hours after placement.

Maintain surfaces in contact with newly placed concrete, including formwork, reinforcement, and subgrade above <\_\_\_\_\_\_\_\_> degrees F.

Place concrete at temperature of not less than <\_\_\_\_\_\_\_\_> degrees F at point of placement.

Mix Concrete at Temperature between:

<\_\_\_\_\_\_\_\_> and <\_\_\_\_\_\_\_\_> degrees F if outside air temperature is above <\_\_\_\_\_\_\_\_> degrees F.

<\_\_\_\_\_\_\_\_> and <\_\_\_\_\_\_\_\_> degrees F if outside air temperature is between <\_\_\_\_\_\_\_\_> and <\_\_\_\_\_\_\_\_> degrees F.

<\_\_\_\_\_\_\_\_> and <\_\_\_\_\_\_\_\_> degrees F if outside air temperature is below <\_\_\_\_\_\_\_\_> degrees F.

Maintenance of Temperature and Moisture:

Following concrete placement, cover with tarpaulins or other readily movable coverings such that only a few <\_\_\_\_\_\_\_\_> feet of concrete is exposed to outside air.

Maintain specified temperature and moisture conditions for newly placed concrete by covering, insulating, housing, or heating.

Arrange for protection methods in advance of placement.

Maintain concrete at temperature of not less than <\_\_\_\_\_\_\_\_> degrees F nor more than <\_\_\_\_\_\_\_\_> degrees F for three days after placement.

Do not remove forms during initial protection period.

Insulation:

Protect insulation against wetting that may impair its insulating value by using moisture-proof cover material.

Keep insulation in close contact with concrete.

Construct enclosure to withstand wind and snow loads and to be reasonably airtight.

Provide sufficient space between concrete and enclosure to permit free circulation of heated air.

Use vented heaters; do not permit heaters to heat or dry concrete locally.

Monitor temperature to ensure concrete is kept within specified limits, recording time and concrete temperature every eight hours.

Construction Forms and Supports:

Maintain relative humidity above 40 percent within heated enclosures until construction supports are removed.

Ensure that concrete has developed necessary strength before removing forms.

Provide additional test cylinders with the same protection as structure they represent to verify concrete strength before construction supports are removed.

If water-curing method is used, terminate at least 12 hours before end of temperature protection period to permit concrete to dry.

After required protection period, gradually reduce concrete temperature within enclosure or insulation at a rate not to exceed <\_\_\_\_\_\_\_\_> degrees F per day until outside temperature has been reached.

* + - * 1. Steel Diaphragms:

Install steel diaphragm extending within <\_\_\_\_\_\_\_\_> inch of full height of wall panel with no horizontal joints.

Joints:

Form vertical joints by roll-seaming or fastening with firm mechanical lock.

Edge seal joints with joint sealant between wall panels that are not roll-seamed.

Diaphragm Openings:

Punctures are not permitted in diaphragm, except those required for pipe sleeves, temporary construction openings, or special appurtenances.

Edge seal openings with joint sealant.

* + - * 1. Accessories:

Coordinate placement of tank accessories.

Set items level, plumb, and in alignment with adjoining Work.

Anchors and Inserts:

Provide anchors and inserts in sufficient number for proper fastening of items.

Embed anchors in concrete to accurately align metalwork at proper level.

Fasteners:

Drill holes as required for bolts and screws in supports and in metalwork.

Conceal fasteners where possible.

Joint Sealant: As required to set, seal, and secure metal items.

* + - * 1. Painting:

Paint tank as specified in Section 099723.24 - Concrete Water Storage Tank Painting.

Apply and cure pipe coatings according to manufacturer instructions.

* + - * 1. Backfilling: As specified in Section [**310000 - Earthwork**].
      1. FIELD QUALITY CONTROL
         1. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than <**\_\_\_\_\_\_\_\_**> days on Site for installation, inspection, startup, field testing, and instructing Facility personnel in maintenance of equipment. Coordinate with Director’s Representative.
         2. Equipment Acceptance:

Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

Make final adjustments to equipment under direction of manufacturer's representative.

* + - * 1. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.
      1. CLEANING
         1. Section 017716 - Contract Closeout: Requirements for cleaning.
         2. Clean interior and exterior of tank to remove debris, including construction items and equipment.
         3. Disinfect tank as specified in Section 330110.58 - Disinfection of Water Utility Storage Tanks.

END OF SECTION 331636