Sanitary Sewer Overflow (SSO) Control and Wastewater Facilities Program

Storage Tank Design Requirements

City of Baton Rouge/Parish of East Baton Rouge
Department of Public Works

Submitted by

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1. Introduction

This document provides requirements for the design of above grade wastewater storage tanks associated with the City of Baton Rouge/Parish of East Baton Rouge (C-P) Sanitary Sewer Overflow (SSO) Control and Wastewater Facilities Program. The term Engineer is defined as an engineering design firm under contract with the C-P and producing engineering design work on the Program. These requirements are provided to encourage consistency in the design approach used by various Engineers.

While the purpose of these requirements is to assure uniformity, it is not intended to stifle Engineer's creativity, design innovation, and ingenuity. Engineers shall review these requirements and adapt them for design of the facilities for which they are responsible. Engineers are ultimately responsible for their design, and this responsibility is in no way diluted or absolved by these requirements.

It may be necessary for the Engineer to deviate from these requirements. In such cases, the Engineer shall immediately bring this matter to the attention of the Program Manager (PM) by completing and submitting the form included in the Program *Requirements for Engineers*. The PM reserves the right to allow or disallow the deviation from the requirements.

2. General

The following general criteria apply to above-ground storage tanks.

- Pre-stressed concrete tank with clear span roof.
- Tanks shall to be 1-20 million gallons (MGs) in volume.
- When flow is pumped into the tank, influent pipe shall have a standpipe with a down spout aimed parallel to the floor of the tank.
- Tanks shall have a sloped bottom to a center sump for drainage. Independent tank drain shall not be needed.
- Tank overflows shall be sized for maximum inflow.
- Manways shall be included through walls, with a minimum of 2 manways provided.
- All piping shall be through the base slab, with the exception of odor control piping, which shall be through the dome.
- The overflow piping shall be piped to the sewer, if possible.
- Any piping that is located under the slab of the storage tank shall be encased in reinforced concrete.
- City water shall be utilized for cleaning of the storage tank.
- There shall be a 25-foot clearance around the perimeter of the tank for construction and a 50-foot setback from exterior fences for site layout issues.
- Site lighting and roads shall conform to C-P requirements.
- Engineer shall provide landscaping as required by the C-P.
- The tank exterior shall have a minimum of 2 coats of acrylic paint. The tank dome interior shall have an embedded HDPE liner with a minimum thickness of 2 millimeters. The tank interior walls shall be coated per instructions from the PM.
- Mixers shall be designed based on Flygt submersible mixers, with access to the mixers through a hatch in the dome or through the wall. Submersible mixers shall mix (stir) with a minimum level setpoint for shutting off/starting the mixer. The mixers shall be sized and configured to minimize solids deposition in the tank.
- An odor control system is required. The type of odor control system shall be a carbon scrubber unless otherwise approved by the PM.
- Roof access shall be by ladder which shall be lockable to prevent unauthorized use.
- If through-the-wall mixers are used, one access hatch shall be provided on the roof for observational purposes.

- Tank level shall be determined by pressure and the instrumentation shall be mounted on the tank influent/effluent piping where it can be easily accessed.
- The C-P will provide their own portable ventilation system for cleaning activities.
- Electrical and controls enclosures shall all be stainless steel NEMA 4X enclosures.
- Lightning protection shall be provided as necessary.
- All accessories shall be called out on the drawings and specifications, including, but not limited to:
  - Manways—number and location.
  - Roof access via ladder.
  - Mixer(s) and access hatches for mixers – number and location.
  - Float control (hard-wired float for HIGH-HIGH water level).
  - Pressure level sensor.
  - Low level alarm.
  - High level alarm.
  - Pump shut-off alarm, if applicable.
  - Backflow-prevented 1 ½-inch hose bibb hydrant at each of the manways for cleaning of the tank with City water.
  - Odor control system.
  - Bottom slope and sump location and dimensions.
  - Exterior and interior coatings/linings.
  - Electrical and control system panels and associated wiring and equipment.
  - Site layout, including clearances and setbacks.
  - Process piping.

3. Site/Civil

The site/civil requirements are general in nature and apply to all design packages. The items covered include roads, drainage, and site utilities.

3.1 Site/Civil Drawings

3.1.1 Survey

All surveying shall be in accordance with the provisions of the Program *Survey Requirements*. If surveying is not performed, existing as-built drawings shall be utilized.

3.1.2 Topographic Base Map (from Surveyor)

Topographic base map shall reflect all existing features of a site and Engineer shall ensure that proposed structures and other improvements do not interfere with features that will be retained and incorporated into the design. Set up the text and symbols in the topographic base map for the drawing scale of 1″=20′.

3.1.3 Overall Site Plan

The overall site plan shall reflect existing and proposed structures, roads, and other major features of the site. The existing features shall be shown screened back with the proposed structures and other improvements shown in bold. The scale of this drawing is generally set up at 1″=40′, 1″=50′, or 1″=100′. Engineer shall select a scale that will cover the entire site and additional areas that will be used for stock pile or borrow sites.

3.1.4 Site Plans

The following additional site plans shall be provided in the design documents:

- Site Demolition Plans
- Site Utility Plans
- Erosion and Sediment Control Plans

4. Structural

4.1 Definitions

Prestressed Tank System: Consists of a cast-in-place concrete floor slab placed on a prepared subgrade, a prestressed concrete vertical core wall, and a cast-in-place concrete roof. All pipes under the tank foundation shall be encased. The footing to wall connection shall be capable of allowing horizontal wall movement without imparting flexural stress into the foundation. The wall to roof connection may be a monolithic joint or may allow the wall horizontal movement without imparting flexural stress into the roof structure.

Shotcrete: Mortar projected jet directly upon intended surface.

4.2 Codes and Standards

The following standards shall be used in the design and construction of the storage tanks:

4.2.1 American Concrete Institute (ACI)

506.2, Specification for Shotcrete

372 Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures

350 Code Requirements for Environmental Engineering Concrete Structures and Commentary

4.2.2 ASTM International (ASTM)

A821/A821M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement

A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

A1008/A1008M, 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

C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

4.2.3 American Water Works Association (AWWA)

D110, Wire- and Strand-Wound Circular Prestressed Concrete Water Tanks

4.2.4 Precast / Prestressed Concrete Institute (PCI)

MNL-120, PCI Design Handbook-Precast and Prestressed Concrete

4.3 Design Requirements

The contract documents shall require that the prestressed tank system be designed by a professional engineer registered in the State of Louisiana, who specializes in the design of prestressed tank systems. The contract documents shall also require that the design of the prestressed tank system conform to the requirements of the following Standards and to the attributes specified in these requirements:

- ACI 350
- ACI 372
- AWWA D110, Type II or Type III construction

4.3.1 Floor Slab

Cast-in-place structural concrete slabs shall have a minimum of two layers of reinforcing in the slab which total .007 times the concrete section. Pile supported structural slabs on grade shall be designed to conform to the requirements of ACI 350.

Provide concrete splash pads at base of tanks in line with overflows on roof. Splash pads shall be detailed to reduce potential for water flowing out of overflows to compromise integrity of foundation slab.

4.3.2 Roof

Cast-in-place concrete clear spanning dome.

4.3.3 Walls

Wall Construction: Shotcrete core wall with continuous internal steel diaphragm, or steel diaphragm embedded within cast-in-place tilt-up concrete wall panels. The walls shall be wrapped with individual layers of prestressing wire and shotcrete. Walls shall be constructed on elastomeric bearing pads, free to move radially, and employ PVC water stop connection between wall and footing.

Openings and Penetrations: Except for limited access manholes, other openings or penetrations through wall shall not be permitted unless a shell analysis is performed and the wall is properly reinforced to account for redistribution of circumferential compressive forces and shears and moments caused by displacement of wires into adjacent bands. Pipe penetrations shall be through floor slab and under footings. Pipe sleeves are allowed through footing for shotcrete equipment.

4.3.4 Appurtenances

Wall Manholes: 53 inches by 33 inches minimum stainless steel frame with stainless steel cover and stainless steel bolts, all Type 316. Design for full liquid level at precast overflows. Manhole shall be airtight and liquid tight.

Roof Access Hatch Cover: Aluminum with Type 316 stainless steel fasteners. Roof access hatch cover shall be designed for a load capacity of 100 psf with a maximum deflection of 1/150th of span.

Exterior Ladder: Aluminum ladder with cage and safety climb device. Provide an intermediate ladder landing, including handrails, for wall heights greater than 35 feet. Entry to ladder shall be lockable to prevent unauthorized use.

Fall Arrest Anchors and Roof Safety Cable System: Provide for tanks with domed roof.

Guardrails shall be 2-rail aluminum guardrail system.

Grating shall be aluminum.

Precast Overflows: Precast concrete overflows. Lower end of overflow openings shall be approximately 1′-0″ above inside spring-line of interior face of wall (3-inches above the top of wall elevation). Locate horizontally to achieve this elevation. Overflows shall be sized and located to allow contents to overflow before placing upward pressure on the underside of the roof structure. Overflows shall include closure devices to contain odorous air but allow liquid overflow.

Miscellaneous Piping, Fittings, and Supports: Provide embeds and supports for Contractor supplied pipes and fittings as shown on the Drawings and as specified. Provide pipe supports for vertical piping at no more than 8′-0″ on center, except for pipe diameters of 24 inches and larger for which the spacing may be 16′-0″ maximum. Pipe supports and associated fasteners and embeds shall be fabricated of Type 316 stainless steel.

4.4 Design Loads and Foundation Criteria

Loads shall be based on the most stringent criteria of the Building Codes and Standards listed above, and loads discussed in the following paragraphs. In all cases the minimum criteria shall conform to the minimum requirements of the IBC with Louisiana Amendments.

4.4.1 Dead Loads

The loads resulting from the weight of all fixed construction, such as walls, floors, roof, equipment bases, and all permanent non-removable stationary construction are considered to be dead loads. Numerical values used for these loads may be determined by either actual known weights of the respective items or by documentation presented in the IBC and other publications such as ASCE 7.

4.4.2 Live Loads

Grating	150 psf
Roof, unless noted otherwise	12 psf minimum on the horizontal projection to tank roof
Walkways and Platforms	150 psf unless noted otherwise

4.4.3 Snow Loads

Ground snow load shall be 0 psf.

4.4.4 Rain Loads

Design for rain loads in accordance with requirements of the IBC and Louisiana Amendments.

4.4.5 Wind Loads

Wind loads shall be 110 mph, Exposure C, Iw = 1.15 in accordance with requirements of the IBC and Louisiana Amendments.

4.4.6 Earthquake Loads

Unless otherwise noted reference ASCE 7:

Spectral Response Acceleration at Short Period (Ss):	0.125 (Figure 22-1)
Spectral Response Acceleration at 1-Second Period (S_1):	0.054 (Figure 22-2)
Site Classification:	D (Assumed – to be confirmed in Geotechnical Report)
Design Spectral Response Acceleration at Short Period (S_{DS}):	0.133
Spectral Response Acceleration at 1-Second Period (S_{D1}):	0.086
Occupancy Category:	III (Table 1-1)
Seismic Design Category:	B (Tables 11.6-1 & 11.6-2)
Importance Factor (I):	1.25 (Table 11.5-1)

Reference ACI 350.3-01, Seismic Design of Liquid-Containing Concrete Structures:

Seismic Zone:	0 (Refer to Figure 4.1)

Modify design in accordance with requirements of ASCE 7.

4.4.7 Thermal Loads

No significant thermal loads are anticipated for these tanks.

4.4.8 Test Loads

No significant test loads are anticipated for these tanks.

4.4.9 Liquid Loads

Drawings shall depict design water levels and top of base slab elevations. The design of the containment structures shall include a check of cracking under normal loads. Sloshing loads during a seismic event shall also be taken into account during the design. Only the available capacity of the member needs to be checked for seismic loads. A unit weight of 65 pcf shall be used for the liquid in these environmental structures.

Load cases that shall be considered in design of liquid holding tanks are:

- All tanks full of liquid to top of wall
- Groundwater with empty tank
- Any tank cell empty or full in any combination

4.4.10 Environmental Loads

Unless more stringent values are determined by the prestressed tank design engineer, the following temperatures shall be used for design purposes:

- Winter Temperature: Water 60 degrees F, and outside air 27 degrees F.
- Summer Temperature: Water 82 degrees F, and outside air 94 degrees F.

4.5 Concrete Design Strengths

All exterior concrete shall be air-entrained. All concrete for hydraulic, or water-holding, structures shall contain a water reducer and a superplasticizer. The minimum 28-day concrete strengths (f'c) are as follows:

- Typical unless otherwise noted — 4,000 pounds per square inch (psi)
- Non-hydraulic slabs-on-grade — 3,000 psi
- Concrete fill — 2,500 psi
- Precast concrete — 5,000 psi, minimum
- Reinforcing steel — ASTM A-615 Grade 60

4.6 Geotechnical

Geotechnical criteria and foundation recommendations shall be developed by a licensed geotechnical engineer based on geotechnical investigations and in accordance with the Program *Geotechnical Investigation Requirements.*

5. Process Mechanical

5.1 Pipe Design Criteria

5.1.1 Piping Schedule

Pipe Designation	Types of Piping
Process Piping, 6” diameter and larger – Above Grade	Flanged ceramic epoxy-lined ductile iron
Process Piping, 6” diameter and larger – Below Grade	Restrained joint ceramic epoxy-lined ductile iron (no thrust blocking allowed)
Process Piping, less than 6” diameter, Above or Below Grade	PVC, either AWWA C900 or Schedule 80

5.1.2 Valves

Process valves shall be non-lubricated plug valves.

Water valves shall be butterfly or gate valves.

5.2 Odor Control

The requirements for odor control will be identified in the Project Definition. The Engineer shall design activated carbon scrubbers for odor control unless otherwise approved by the PM. At least two fans shall be installed. One or more carbon scrubbers shall be provided. Odor control scrubber connections shall be based upon site-specific requirements and conditions.

At some sites a pump station may be associated with the storage tanks that operates continuously and requires odor control using biotowers in accordance with the *Pump Station Design Requirements.* In these situations, a combined odor control system may be used for the pump station(s) and the storage tank(s) using biotower technology.

5.2.1 Design Criteria

Design Air Flow Rate. Air flow equal to maximum tank fill rate plus adequate air to maintain a minimum inlet face velocity of 300 fpm at the tank vents

Maximum carbon superficial velocity – 55 fpm

H2S inlet conditions:

- Average concentration 10 ppmv
- Maximum concentration 200 ppmv

Removal efficiency—99 percent minimum

5.2.2 Odor Ducts

Fiberglass (FRP) shall be used above grade

Penetrations through concrete shall be 316 stainless steel

Buried duct work shall be HDPE and shall have drainage provisions

5.2.3 Fans

Fans shall be FRP construction with constant speed motors (TEFC). To the extent possible, the odor control fans shall be oriented to direct noise away from adjacent neighborhoods.

6. Building Systems

If a building is required for the project, refer to the Program *Pump Station Design Requirement* for applicable requirements.

7. Instrumentation and Controls Design Criteria

Instrumentation and Controls (I&C) System is an inclusive term covering the instrumentation, the Process Monitoring and Control System (PMCS), the Wide Area Network (WAN), the Information Management Systems (IMS), and telemetry. The Engineer shall reference the Supervisory Control and Data Acquisition (SCADA) Master Plan for instrumentation and controls design criteria.

8. Electrical

Electrical designs shall meet the requirements of the National Electric Code (NEC). Hazard classifications shall be as defined in NFPA 820. Where applicable, C-P standard specifications and details shall be utilized.

8.1 Power Distribution Planning

8.1.1 Power Interruptions

The design shall include specific requirements and provisions to minimize power interruptions to the existing facilities, and shall include construction sequence guidelines for the contractors.

The storage facility shall be supplied with a generator to be sized by the PM. The generator shall meet the requirements as described in the Program *Pump Station Design Requirements*.

8.1.2 Distribution System Equipment

All equipment furnished shall be rated for the maximum available short circuit current. Only fully rated equipment shall be provided. Series-rated equipment shall not be provided.

All power distribution equipment shall be installed in clean, dry spaces dedicated to electrical equipment. The spaces shall be above finished grade in areas not subject to flooding. The electrical design engineer shall adhere to the following:

- 480-volt switchgear shall be large air industrial drawout circuit breakers with static trip units.
- 480-volt switchgear shall include:
  - Main incoming breakers UL listed suitable for service entrance.
  - Bus bars rated to withstand short circuit and sized to carry required full load amps continuously.
  - When double ended switchgear is used, provide key interlocks to prevent closing the tie breaker when both incoming breakers are closed.
- All switchgear rooms shall be ventilated and dehumidified, or air conditioned to suit local conditions.
- 480-volt MCCs shall include:
  - Combination starters of the motor circuit protectors (MCP) type having type 2 overload protection.
  - See Section 8.3 below for requirements of motor starters.
  - Incoming breakers shall be UL listed suitable for service entrance equipment as required by NEC.

- MCCs shall accommodate adjustable frequency drives up to 100 HP ratings. Drives above 100 HP shall be mounted in separate free standing enclosures fed by a feeder breaker within MCC.
- Bus bars to withstand available short circuit current and sized per NEC requirements.
- For large MCCs, a double-ended feed shall be required. Where double ended MCCs are used, provide key interlocks between the two main incoming breakers and tie breakers, preventing closing the tie breaker if both incoming breakers are closed.
- Provide surge arrestors in the incoming compartment.

8.1.3 Raceway Systems

All rigid conduit and cable trays shall be aluminum.

8.1.4 Enclosure Types

Enclosures shall be selected to be consistent with area classifications.

Use stainless steel NEMA 4X enclosures in all areas designated "corrosive," and all outdoor areas.

Use NEMA 7 enclosures in all areas designated "hazardous."

8.1.5 Wire and Cable

All applicable codes, such as those of the Insulated Cable Engineers Association (ICEA), shall be followed when designing wire and cable.

8.2 Distribution System Protection

Designers shall apply sound engineering practices when selecting devices to prevent equipment damage and system failures caused by overcurrents and transient voltages. Equipment shall be chosen with adequate momentary and interrupting capacity for the point in the system where it is used. All equipment shall be fully rated for the available fault current. Series-rated equipment shall not be used.

Phase and ground fault protective devices and device settings shall be provided that will disconnect the portion of the system in trouble while disturbing the rest of the system as little as possible.

8.3 Motor Protection and Control

Each motor shall be installed with a suitable controller and devices to protect the equipment and perform the functions required.

If two or more three-phase motors are in the same area, MCC-type construction shall be used. NEMA Class 11, Type B construction shall be used unless conditions dictate otherwise.

For motors below 75 hp, combination motor starters with magnetic trip-only molded-case circuit breakers with Type 2 overcurrent protection rating shall be provided.

For motors rated at 480V, 75 hp and larger, solid state starters complete with isolation contactor, bypass contactor, current/voltage ramp up and down feature, and cooling fans shall be provided.

Solid state or reduced voltage auto-transformer type starters shall be provided where applicable.

8.3.1 Overload Protection

Each motor shall have thermal overload protection in all ungrounded phases. The controller-mounted relays shall have external manual reset.

Thermal protectors that are embedded in the motor windings shall be considered for motors exceeding 100 hp and up to 350 hp. The thermal protectors shall be able to reset manually. Embedded protector circuits shall be fused to motors in accordance with the manufacturer's recommendations.

Resistance thermal detectors (RTDs) shall be provided for motors 400 hp and larger.

8.3.2 Design Documents

Ladder-type control diagrams shall be prepared for each motor, showing all control wiring, pilot devices, auxiliary contacts, inputs and outputs to the starter I/O boards, and external connections. A single diagram may be used for more than one motor having the same control.

8.3.3 Control Wiring Installation Drawings

The suppliers of electrical, instrumentation, and control equipment are responsible for furnishing wiring diagrams of motor control centers, switchgear, and control panels. The electrical contractor shall furnish drawings for all electrical equipment. The process instrumentation and control system contractor shall furnish control and interconnection and loop sheets for each instrumentation loop. The electrical and instrumentation contractors shall mock up the contractor drawings and manufacturer’s shop drawings to reflect as-built information.

8.4 Motors

All motors driving equipment used for wastewater treatment shall be easily accessible for operation and maintenance. Enclosures for both horizontal and vertical motors less than 200 hp shall be totally enclosed, fan cooled, and severe duty, and built for indoor or outdoor locations. Submerged motors shall be totally submersible and air- or oil-sealed. Service factors shall be 1.15. Bearings shall be rated 100,000-hour B-10 life according to the Anti-Friction Bearing Manufacturers Association's standards. Enclosures for motors greater than 200 hp shall be determined on an individual basis, considering cost and protection requirements. Motors connected to variable frequency drives shall be drive-duty rated, special inverter duty motors.

Bearings for horizontal motors of all sizes shall be grease-lubricated, with addition and relief fittings.

Bearings for vertical motors of sizes 200 hp and smaller shall be grease lubricated, with addition and relief fittings. Bearings for motors 250 hp and larger shall be oil-lubricated with constant-level oilers.

Motors shall have copper windings.

Motors rated 100 hp to 350 hp used in damp or outdoor locations shall have space heaters to prevent condensation.

Motors greater than 150 hp shall have thermal protectors built into their coils to protect stator windings.

Totally enclosed fan-cooled (TEFC) motors shall be equipped with weep holes and drain plugs to drain condensation.

The following monitoring devices for electric motors shall be furnished:

- Motors ½ hp to 150 hp—control power status, run status, ready status, run time, local selector switch status, local Emergency Stop position status, and motor current
- Greater than 150 hp—all the devices required for ½ hp to 150 hp, plus motor winding temperature, phase voltages, vibration monitoring, speed signal, power factor, and ground fault. Solid-state multifunctional relays shall be provided.

8.5 Grounding

Each design shall include a complete grounding system for the electronic and power systems.

8.6 Field Testing

Specifications shall require that the contractor have a NETA-approved testing firm test the electrical distribution system. The testing firm shall perform the following field tests and document the results:

- Perform high potential tests on all medium-voltage cables.
- Test existing and new switchgear, protective relays, bus work, and circuit breakers.
- Test all medium-voltage switchgear for proper operation and protection.
- Test all MCCs and motor control equipment for proper operation and protection.
- Set and test all protective relays, circuit breakers, fuses, and overload protection in accordance with the final coordination and short-circuit analyses.
- Test ground resistance of the grounding electrode to determine compliance with the ohmic value specified.
- Test all ground-fault interrupter receptacles and circuit breakers for proper connection and operation with methods and instruments prescribed by the manufacturer.
- Test all ground-fault relays and other protective devices used for distribution system protection.
- Test all solid-state trip breakers at full current.
- Verify total and individual current and voltage harmonic distortion at points of common coupling at MCCs, switchgear, and distribution transformers with specified operating scenarios. This is applicable to the operation of adjustable frequency drive (AFD) systems. Test harmonic distortions for both normal and standby source operation.
- Testing shall be in accordance with NETA-published testing recommendations and standards. A final test report shall be provided by the testing firm.