

APPENDIX 5C

Inspection Guidelines for SPU Water Storage Facilities

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Chapter I INTRODUCTION

This appendix provides guidelines for type and frequency of inspections for SPU water system storage facilities. Because the lifecycle of these facilities is long (50 or more years), most of the water storage requirements within the SPU system will be met with existing storage facilities. Periodically, these facilities will require refurbishments to continue to meet their operational and design requirements. Refurbishments can include re-coatings, structural or seismic upgrades, security improvements, and modifications for maintaining water quality. All of these require some level of design.

SPU conducts three types of inspections on water storage facilities: routine, periodic, and comprehensive. If a facility has potential structural integrity concerns, then those facilities should be inspected more frequently than semi-annually. A frequency of every 3 to 5 years is an accepted industry guideline for comprehensive inspection. Actual frequency should be based on the age and condition of the storage facility.

Table 5C-1
Inspection Types for Some SPU Water Storage Facilities

Type	Description	Frequency	Responsibility
Routine	Exterior survey accessible from ground	Daily Weekly	Security Facilities Operations and Maintenance
Periodic	Exterior survey not accessible from ground and visual interior inspection	Semi-annually or annually	Water System Operations
Comprehensive	Coating and roofing Interior Annual leakage test for earthen dam concrete reservoirs	When cleaned For other concrete reservoirs, leakage test when cleaned	Water System Operations

I.1 ROUTINE INSPECTIONS

SPU security inspects the exterior of the storage reservoir and grounds daily for evidence of intrusion, vandalism, security integrity, general gross structural conditions (visible from the exterior), and obvious leakage from pipes. Operations inspect these facilities weekly. Routine inspection observations are documented on a checklist.

1.2 PERIODIC INSPECTIONS

Periodic inspections review areas of storage facilities not normally accessible during routine daily activities. These include visual checks of both the exterior and interior.

Semi-annual or annual periodic inspections at each reservoir document the following:

- Roof hatches and visible roof structural components
- Vent and overflow screens
- Floating covers
- Locks on reservoir hatches, to manholes or doors
- Valve chamber including piping, valves, seals, and other appurtenances
- Changes in water color, odor or turbidity (visual observation through hatches)
- Appearance of any algae, slime, worm growths, or of floating or settled materials (visual observation through hatches)

Each year, a visual inspection of each storage facility must be performed to include all of the items listed above, including the general condition of the interior. The water level should be lowered to the extent practicable to expose as much of the interior surface as possible. After several years of operation, conditions in the upper portion of a facility's interior can vary significantly from those in the middle and lower portions.

After a major windstorm or snow or ice storm, SPU does a periodic inspection of each storage facility to determine if any damage has occurred.

Operators/inspectors performing periodic inspections require training in confined space entry procedures. Proper precautions must be taken to assure employee safety.

The operator/inspector must make observations and document the observations on the periodic inspection checklist.

1.3 COMPREHENSIVE INSPECTIONS

SPU does comprehensive inspections to get a detailed assessment of storage facility components. These inspections evaluate the structure's integrity, protective coating, and features and appurtenances that influence sanitary integrity.

1.3.1 Frequency

The frequency of comprehensive inspections varies for each storage facility depending on source water quality, water treatment, age, type and size, water quality, and regulatory requirements. An accepted industry guideline for comprehensive storage facility inspection is every 3 to 5 years.

From a structural and coating standpoint, new and well-maintained storage facilities can be inspected at the longer interval of 5 years. Older storage facilities that have already experienced either extensive metal loss due to corrosion or concrete deterioration should be inspected every 3 years.

From a water-quality and sanitary standpoint, inspection and subsequent cleaning may need to be more frequent than 3 to 5 years. From a sanitary standpoint, frequency is driven by water quality, biofilm, and sediment build-up. Historically, sediment buildup in SPU tanks and reservoirs has not been a significant problem.

An inspector with at least 3 to 5 years of experience with water storage facility inspections and proper training in both storage facility structures and protective coatings can do the fieldwork for most storage facility inspections where no abnormal structural condition is suspected.

A contract inspection firm may be procured to perform comprehensive inspections. Preferably, the inspection team should include a National Association of Corrosion Engineers (NACE) Certified Coating Inspector and a licensed professional structural engineer to perform a thorough structural evaluation on older facilities suspected to be in poor condition.

1.3.2 Inspections Items

A comprehensive inspection shall at a minimum provide a detailed review of the following items:

- Exterior coating or concrete surface (as applicable) condition
- Foundations and visible footings
- Geotechnical and drainage features
- Structural components, such as columns, beams, stiffeners and wind rods
- Points of pipe penetrations and seals
- Concrete joints and cracks that may result in leakage
- Ladders, vents and safety devices
- Interior surface / coating condition
- Cathodic protection system
- Overflow and drain pipes, weir boxes, vents, and screens
- Interior sediments type and amount
- Biofilm conditions (if any)
- Valve chamber and all associated structural, mechanical, and electrical components
- Floating reservoir covers and tensioning systems (if any)

If sediments are found during inspections, samples should be analyzed for content and source.

If leaks are suspected or found during a comprehensive inspection, more detailed inspection should be done to determine the source and extent.

1.4 STRUCTURAL INSPECTIONS

1.4.1 Steel Storage Tanks

Structural integrity of steel storage tanks is primarily affected by corrosion. Corrosion can attack specific portions of the tank that can create significant structural problems and weaken a

storage facility structure. Corrosion on interior surfaces of a water storage tank can take two forms: pitting or uniform sheet corrosion.

Inspections of steel storage tanks must include inspecting visible dents, creases, buckled tension rods, evidence of soil movement around foundations, interior coating conditions, and metal loss. While most of these items are visible, actual metal loss must be measured.

Inspectors must routinely look for any possible soil movement damage to the structure.

For tower-supported tanks, indications of damage could include the following:

- Cracked coatings or welds at tower connections
- Broken, bent or sagging rods
- Buckled struts
- Dented or twisted columns
- Missing or loose rod pins

After an earthquake or a major wind, snow or ice storm, a visual structural inspection of each steel storage tank must be performed to determine if any damage has occurred. This is non-routine maintenance that is performed after each event.

1.4.2 Concrete Storage Reservoirs

Structural condition assessments of concrete reservoirs must be performed with the guidance from the storage facility manufacturer. Such inspections should include inspecting for any signs of settlement of foundations or footings, cracked foundation ring walls or other visible damage, concrete crumbling, sand deposits on floor of facility, deteriorated cement mortar, deep cracking, increased leakage and exposed reinforcing steel.

After a major windstorm or snow or ice storm, a visual structural inspection of each concrete storage reservoir must be performed to determine if any damage has occurred.

1.5 PROTECTIVE COATING INSPECTIONS

Typically, coatings are applied to the exterior of steel storage facilities for protection against corrosion, and for appearance and aesthetics. Interior coatings are applied to protect against corrosion and enable the facility to withstand constant immersion in water, varying water temperatures and alternate wetting and drying periods.

1.5.1 Epoxy Coatings Inspections

Inspections of epoxy coating systems must include examination for flaking, peeling, and rust; tests to evaluate the thickness, type and adhesion of the existing coating; and estimation of percent coating failure to rust and primer.

Tests to identify the type of existing coating on the tank must be done to determine the possibility of top coating instead of a complete coating removal and repaint. With removal of

the existing coating, there is the potential need to dispose of any removed coatings as hazardous waste.

The coating inspector must use a series of measures to evaluate the condition and integrity of a coating. The most widely used measures are American Society for Testing Materials (ASTM) procedures. These procedures provide field methods and comparative standards for assessing the degree of chalking, rusting, checking, blistering, and adhesion. ASTM standards enable the experienced inspector to assign qualitative grades to each coating, which forms the basis of the integrity assessment.

1.6 INSPECTIONS FOR LEAKS

Water loss resulting from leakage from storage facilities results in wasted water, but more importantly can undermine the foundation of the structure causing extensive repairs or possibly catastrophic failure.

The standard approach involves taking the facility off-line and monitoring water level over a period of time sufficient to determine changes in level and based on configuration and evaporation, from which water loss rates can be calculated. Such tests may be performed as part of the comprehensive inspections.

Leaks in storage facilities can sometimes be identified and pinpointed by divers or remotely operated vehicles. The leak detection method involves looking for a disturbance in bottom sediment patterns. If significant leakage is suspected and verified, and no one area can be identified, then a cleaning and lining program may be required to seal up the bottom. With larger leaks, a dye test can be used. Food coloring may be used as a dye; however, to avoid alarming customers, the reservoir must not be returned to service if any dye is visible in the water in the reservoir. No standard reference is known for conducting a dye test.

Because most SPU storage facilities have foundation underdrain systems, regular monitoring of underdrain flows should be performed as an indication of leaks.

1.6.1 Methods of Comprehensive Interior Inspections

This section outlines the general methods and considerations for the interior inspection of storage facilities. Interior inspection methods include float down inspection and wet inspection such as diving or utilizing a remotely operated vehicle (ROV).

1.6.1.1 Float Down Inspections

Float down inspections may be conducted using trained SPU personnel or outside contractors. The entry into the facility is considered a confined space operation and all OSHA/WISHA requirements must be met. The following is the float down inspection procedure:

1. SPU raises the water level to permit access from the roof hatches
2. SPU disinfects the rubber raft per AWWA Standard C652 before entry
3. Inspector inflates the raft inside the storage facility. Inspector must have a full body safety harness and be attached to the roof by a safety line. Inspector should also be

dressed in a dry suit and life jacket disinfected in case the raft flips over. If there are a large number of columns in the reservoir, tethering to the roof may not be practicable.

4. Safety attendant must be on the roof at all times
5. Inspector enters the raft and visually inspects the roof and walls as the SPU lowers the water level as far as possible
6. Inspector photographs the interior surface conditions and performs any measurements required. Generally, this type of inspection will permit the inspector to directly view 50 to 60% of the interior walls and to see the bottom to ascertain if sediment is present.

Inspector or designee prepares a Safety Plan and coordinates with the Safety Group. In some situations, it is advisable to notify the Fire Department in advance of the inspection in case there is a need for rescue.

1.6.1.2 Wet Inspections

Two alternative types of wet inspection methods can be performed while the storage facility is full of water, including diving and use of a remotely operated vehicle (ROV).

1.6.1.3 Diving Inspection

A diving inspection uses specially trained commercial divers to enter a full storage facility to make internal observations on the structural and coating conditions. The safety of divers and protection of the finished water quality are spelled out in AWWA Standard D101. To meet these requirements, divers must be commercially certified, use dry suits, and have external air supplies, underwater communications gear and safety lines. All equipment must be dedicated for potable water use and must be disinfected on site before every inspection. The advantages of a diver inspection also include the ability to reach all of the internal surfaces directly. Unlike a dry inspection in which only limited portions of a storage facility can be directly inspected, a diver can swim up to all of the shell surfaces and within reach of the roof depending on water level during the inspection. It is important to fill the storage facility to the overflow before each inspection.

One disadvantage of a diver inspection is that the storage facility must be taken off-line to create safe conditions for diving.

1.6.1.4 Remotely Operated Vehicles (ROVs)

ROVs have been developed to inspect water storage facilities with no interruption to service, eliminating the need to operate valves and to keep people from contacting the water. These vehicles provide high-quality, closed circuit video to an onsite inspector that operates the unit and makes observations. ROVs can be equipped with specialty devices such as cleaning brushes, ultrasonic metal thickness gages, and laser scaling. With these accessories, an ROV can perform all of the functions of a diver. These vehicles should always be disinfected onsite. ROVs are made of non-porous materials and can be cleaned and disinfected before each use. The ROV inspection company should use bearing seals filled with a food grade glycerin. This material can leak and normal hydrocarbon lubricants would contaminate the storage facility.