



Guidance for Assessing and Certifying Tank Systems



Revised November 2014

Publication Number 94-114

Publication and Contact Information

This report is available on the Department of Ecology's website at www.ecy.wa.gov/biblio/94114.html

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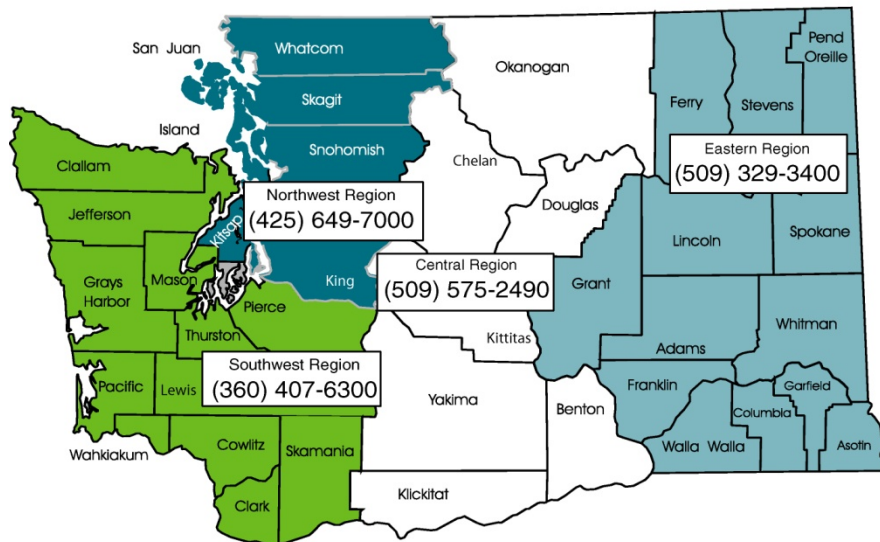
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Introduction

Tank system assessments and certifications are required for:

- Tank systems currently in use
- Design of new tank systems
- Tank system installations
- Extensive repairs of existing tank systems

This guide is for owners, operators, and those who conduct integrity assessments of tank systems that store and treat dangerous waste. Assessments are required by state Dangerous Waste regulations ([WAC 173-303](#)).

Assessments may be conducted by any qualified person. However, they must be reviewed and certified by an "independent, qualified, registered professional engineer."

An "*independent, qualified, registered professional engineer*" is a person who is licensed in Washington State, or a state that has reciprocity with the state of Washington. This person cannot be an employee or operator of the facility whose tank systems are being assessed.¹

A "*qualified*" professional engineer is a person who has training and expertise in tank system design and installation. The engineer must be able to recognize potential tank system failure or past failures. The engineer must be able to assess and interpret information about dangerous waste stored in the tank, and its compatibility with tank and piping system materials.

Assessment reports must include a signed, written statement certifying the accuracy, truthfulness, and completeness of the material presented and conclusions reached in the report. See WAC [173-303-810\(13\)\(a\)](#) for the language that must be included in the report.

An integrity assessment confirms that a tank system is designed adequately, has sufficient structural strength, and is compatible with the type of waste stored or treated. For tank systems storing material that becomes a dangerous waste, an integrity assessment must be performed within one year after that material becomes a dangerous waste. An independent, qualified, registered professional engineer must certify that the system will not collapse, rupture, or fail.²

The regulatory terms "existing" and "new" tank are based on EPA's 1986 federal register definitions and can be confusing today.¹

Existing tank means a system or component used for storage or treatment of dangerous waste and that is in operation or was installed, before February 3, 1989.

Regulatory requirements and procedures for **tank system closures** are discussed in Ecology's *Guidance for Clean Closure of Dangerous Waste Facilities*, publication #94-111. You can access this guidance from <https://fortress.wa.gov/ecy/publications> or get a copy from your regional Ecology office.

¹ WAC [173-303-040](#).

² WAC [173-303-640\(2-3\)](#) and [-810\(13\)\(a\)](#).

New tank means a system or component to be used for storage or treatment of dangerous waste that was installed after February 3, 1989.

Newly designed and installed tank system assessments must have a schedule for future assessments.³ The initial design assessment establishes baseline conditions for comparison with later assessments. Future assessments must, at a minimum, include a tank system integrity examination and consider:

- Current and past assessments.
- Age of the system.
- Materials of construction.
- Characteristics of the stored waste.
- Any other relevant data.

Other data to be considered during assessments might include:

- Facility description.
- Available design plans and as-built drawings.
- Operation and maintenance records.
- Records of daily inspections by facility staff.
- Waste characterization data.
- Inspection records.
- Records of previous assessments.
- Existing test reports.

Standards and practice codes related to tank assessments are listed in the Appendix at the end of this document.

1.1 Classifications of Tanks

Dangerous waste tank systems consist of the tank itself, a secondary containment system, if required, and ancillary equipment. Ancillary equipment can include piping, fittings, flanges, valves, and pumps.⁴

There are four classifications of tanks that store and treat dangerous wastes:

- 1. Above-ground** The entire surface area of the tank is above the surrounding ground and its entire surface area, including the tank bottom, can be visually inspected.
- 2. On-ground** The tank sits directly on the ground and the bottom of the tank cannot be visually inspected.
- 3. In-ground** A portion of the tank is below the surrounding ground and cannot be visually inspected.
- 4. Underground** The tank is entirely below the ground surface.

³ WAC 173-303-640(3)(b).

⁴ WAC 173-303-040.

Integrity Assessment of Tank Systems Storing Dangerous Waste

This chapter contains guidance for integrity assessments to be conducted over the life of the tank system, as required by WAC [173-303-640 \(2\)\(e\),\(3\)\(b\)](#). A design assessment is required for all new tanks (see Chapter 3).

The professional engineer responsible for certifying the integrity assessment should obtain and review applicable documents regarding the tank system. The documents needed to conduct a thorough assessment include:

- Available design plans and as-built drawings
- Operation and maintenance records
- Records of facility staff inspections
- Existing test reports
- Waste characterization data
- Records of previous integrity assessments

2.1 Tank Structural Integrity

Assessing structural integrity involves an external visual inspection and another method, such as a leak test or internal visual, ultrasonic, magnetic particle, or radiography inspection.

External visual inspection

An external visual inspection should identify any major or obvious problems. For example, significant cracking in the tank wall means the tank system is unfit for use and must be taken out of service.

An external visual inspection should look for:

- Significant cracks or spalling (flakes of broken off material) in concrete pads and concrete secondary containment structures.
- Excessive or uneven settlement of the tank foundation, such as distortion and cracks around anchor bolts that attach a tank to an underlying concrete pad.
- Rust, pitting, and other visual evidence of corrosion on the exterior of metal tanks and ancillary equipment, especially at grade level, roof areas, and connections.
- Deterioration of exterior coatings, such as rust spots and blisters.
- Damage to insulation.
- Evidence of leaks around the tank or ancillary equipment, such as discoloration of coatings.
- Cracks or evidence of leaks at joints and welds, especially at connections.
- Loss of metal thickness on the tank bottom and sides.
- Cracks on fiberglass tanks.

- Signs that the concrete structures chemically react with the waste stored in the tank. Look for potential reactions with sulfates, acids, and alkali aggregate reactions.
- Evidence of leaks around joints on concrete tanks and vaults.
- Tank system coatings and linings that have cracks, gaps, swelling, blistering, or crinkling.

External visual inspection combined with other methods

An external visual inspection cannot be the only assessment method for confirming tank structural integrity. Continued use of a tank system can only be certified by a combination of the external visual inspection method with another. Below is a list of methods that can be combined with an external visual inspection:

An **internal visual inspection** requires that a tank be emptied and cleaned so it can be inspected. The American Petroleum Institute Standard 2015 has more information on cleaning storage tanks. Ultrasonic, radiography, liquid penetrant, or magnetic particle inspection methods should be used with an internal visual inspection. Using a remote-controlled video camera can eliminate the need to enter a tank for inspection. A camera can also produce a video record.

Ultrasonic equipment uses ultrasonic waves to measure the thickness of the roof, wall, and bottom of metal tanks. Corrosion is evaluated, as well as the location and size of specific defects in the tank's structure and welds. This equipment does not require the tank to be emptied.

Radiography equipment uses either x-rays or gamma radiation to detect cracks and voids in piping, repair welds, ancillary equipment, and other solid materials. This equipment requires an operator trained in how to avoid excessive exposure to x-rays or gamma rays.

Liquid penetrant methods use dyes to detect the extent and size of surface cracks on the outside of a tank and cracks in welds that are not seen in a visual inspection. The surface is first cleaned well, often by sandblasting, then dye is brushed or sprayed on and the excess removed. After a few minutes to allow the dye to penetrate into any cracks, a chemical developer is applied to the surface, exposing any defects. This method can be used on both tanks and piping constructed of metallic materials and non-metallic materials.

The **magnetic particle method** is used to detect surface cracks on metal tanks and welds that are not observable by visual inspection. This method requires careful cleaning of the surface, then applying iron particles to the surface. This does not provide information on crack depth and cannot be used on non-metallic tanks.

Leak Testing is required for underground tanks that cannot be entered.⁵ Leak testing can be used to assess the structural integrity of above-ground, on-ground, and in-ground tanks. Volumetric methods for leak testing include tank tightness testing, installing appropriate sensing devices around the exterior of a tank system, or using environmentally neutral volatile tracer compounds combined with soil gas monitoring techniques.

Although dangerous waste regulations do not specify a performance standard for leak testing, any leak testing method used must account for⁵:

- high water table effects

⁵ WAC [173-303-640\(2\)\(c\)](#).

- temperature variations
- vapor pockets
- tank end deflections (deviations)

2.2 Compatibility of Waste to be Stored or Treated

The physical and chemical characteristics of the waste being stored or treated must be considered in the assessment.⁶ The dangerous waste must be compatible with the tank and ancillary equipment. Any portion of the tank system that comes into contact with the waste, such as the tank shell, piping, lining, fittings, or secondary containment, must not deteriorate.

For example:

- Highly corrosive wastes such as bleaches and acidic compounds should not be stored or treated in an unlined steel tank.
- A waste with a high concentration of nitrobenzene should not be stored or treated in a fiberglass tank.

You can get compatibility information from the manufacturers' specifications and other sources, such as *Perry's Chemical Engineers' Handbook*. Manufacturers can provide documentation of the specific tests and methodologies (for example, ASTM C581 cited in the appendix) conducted to evaluate the compatibility of tank material with various substances. Compatibility tests should be conducted for a long term (more than 6 months).

The tank assessment should contain a review and reference the compatibility information available, indicating whether the tank is adequate for storing or treating the material that is or will be in it. For example, if the tank previously stored a less dense waste, the engineer must recalculate the maximum fill height for the current waste.

Any tank or tank system that is determined to be incompatible with the waste being stored or treated should be identified as unfit for use and immediately removed from service.

2.3 Ancillary Equipment

Failure of ancillary equipment, including failures of piping, pumps, flanges, and couplings could release dangerous waste. Piping and ancillary equipment must be assessed using leak testing or another appropriate method, such as radiography.⁷ Also, check piping connections and penetrations of tanks and secondary containment structures.

2.4 Secondary Containment

Secondary containment prevents the release of dangerous waste to the environment. It is required for tank systems that store or treat dangerous waste. Dangerous waste regulations define the term "*tank system*" to include the containment system associated with a tank.⁸ An assessment must include the secondary containment system.

⁶ WAC [173-303-640\(2\)\(c\)\(ii\)](#).

⁷ WAC [173-303-640\(2\)\(c\)\(v\)\(B\)](#).

⁸ WAC [173-303-040](#) and [-640\(4\)](#).

Secondary containment must be made of one of the following⁹:

- An external liner
- A concrete vault
- A double-walled tank
- An equivalent device approved by Ecology.

External Liners

An external liner provides a barrier to waste from being released into the surrounding environment. Liners are made of impervious materials that must be compatible with the waste being stored or treated in the tank system.¹⁰

Liners should be inspected for abrasions, cracks, punctures, and gaps. The inspection engineer should look for deterioration.

Concrete Vaults

Interior and exterior surfaces of concrete vaults and structures used for secondary containment should be assessed for cracks, spalls, and other conditions. The interior surface and joints of a concrete vault must be coated with material that is chemically compatible with the waste being stored or treated.¹¹

[The American Concrete Institute](#) offers helpful publications:

- 201.1R-08 provides guidance and a checklist for assessing the condition of concrete structures and defines the various types of defects in concrete structures.
- 224.1R-07 discusses nondestructive testing methods such as ultrasonic or radiography equipment. These methods can determine the depth of cracks and voids visible at the surface.

Double-Walled Tanks

The outer walls of double-walled tanks must be¹²:

- chemically compatible with the waste being stored or treated
- protected from corrosion
- provided with a continuous leak detection system
- inspected for cracks, pitting, and deterioration.

Buildings Used for Secondary Containment

Buildings that surround one or more tanks can provide secondary containment if they are constructed to meet the same secondary containment design requirements.

Secondary containment buildings must prevent runoff or precipitation inside the building. Sumps or other containment methods must be able to contain 100 percent of the capacity of the largest dangerous waste tank enclosed by the building.¹¹

The portion of the building designated as secondary containment must have an impervious coating that is chemically compatible with the wastes stored or treated in the building.

⁹ WAC [173-303-040\(4\)\(d\)](#).

¹⁰ WAC [173-303-640\(4\)\(c\)\(i\)](#).

¹¹ WAC [173-303-640\(4\)\(e\)\(ii\)](#).

¹² WAC [173-303-640\(4\)\(b\)\(i\)](#) and [-640\(4\)\(e\)\(iii\)](#).

2.5 Tank System Corrosion

Corrosion is a significant cause of tank system failure. For this reason, inspectors should check existing corrosion protection measures.¹³

In addition to the properties inherent to the waste and the tank system, the need for corrosion protection measures is based on factors such as:

- Properties in the soil surrounding the tank system, including moisture content, pH, resistivity, structure to soil potential, sulfide, and chloride content.
- Presence of stray electric currents from nearby electrical equipment using an external power source.
- The presence of nearby underground metal structures.

Corrosion protection Methods

If the inspection reveals corrosion concerns, a corrosion expert must evaluate the existing protective measures, and recommend actions to ensure the integrity of the tank system during its use.

Special procedures are needed to ensure cathodic systems and impressed current systems are operating properly:

Sacrificial anode cathodic system

To determine whether a sacrificial anode cathodic protection system is working, measure the voltage between the tank or piping surface and a reference electrode, such as a saturated copper-copper sulfate electrode. The electrode should contact the soil immediately adjacent to the tank or piping. To protect steel, for example, -0.85 volts or a more negative value (with respect to the copper-copper sulfate reference electrode) is adequate cathodic protection.¹⁴ Evaluate these systems six months after installation and annually thereafter.

Impressed current system

The rectifier output on impressed current systems should be checked every two months. Adjust the voltage and current output from the rectifier to ensure a continuous and adequate flow. Electrical continuity and isolation should be checked when these features are required as part of the corrosion protection system. Document these checks in the operating record of the facility.

Verifying actual corrosion rate

Ultrasonic techniques can be used to verify the corrosion rate. Check to see that remaining thickness is within corrosion allowance based on an assumed rate of corrosion. If a corrosion coupon is in place, use it to verify the corrosion rate.

2.6 Tank Anchoring

Safely anchor tanks to protect from wind storms, earthquakes, and other forces to “ensure that it will not collapse, rupture or fail.”¹⁵ The qualified, independent professional engineer should confirm adequate design and operation of a tank’s anchoring system to meet International Building Code (IBC) standards.

¹³ WAC [173-303-640\(2\)\(c\)\(iii\)](#).

¹⁴ NACE International, Standard SP0285-2011, <http://www.nace.org>

¹⁵ WAC [173-303-640\(2\)\(c\)](#) and [-640\(3\)\(a\)](#).

Some individual tank design standards have additional requirements for anchoring. For example, Appendix E of API 650 addresses seismic design of storage tanks. These requirements should also be considered during a tank system integrity assessment.

2.7 Bonding and Grounding

Tank systems must be designed and operated to prevent the ignition of combustible or flammable liquids.¹⁶ Bonding and grounding is needed if the liquid flow into or out of the tank can create a static charge and if the liquid is managed above its flashpoint. If the tank and piping are not bonded and grounded, a spark generated by static charges can ignite vapor above the liquid, resulting in a fire or explosion.

The tank system assessment should evaluate whether the tank system is appropriately bonded and grounded. Refer to NFPA 30, Flammable and Combustible Liquids Code, for bonding and grounding requirements.

2.8 Tank Level Control and Tank Venting System

Tank systems must be equipped with spill and overflow prevention controls¹⁷. A tank must have some form of high liquid level indicator or liquid level pump cutoff device to prevent overflowing. The indicator may be audible or visual and must be designed to work well in its operating environment. The liquid level sensing device must be tested regularly.

If a tank assessor determines that a tank can be used for storage of specific liquids higher than the maximum fill level, it must be documented and not exceeded. A tank assessment should address whether the spill and overflow prevention controls are in place and operational.

A tank system must be appropriately vented to prevent ruptures, leaks, or failures.¹⁸ The assessment should list the tank venting standards or codes the tank system is meeting, such as API 650, API 2000, UL 142, or NFPA 30.

Some tank systems are subject to [WAC 173-303-640\(11\)](#) and are equipped with controls like pressure-vacuum relief devices. The tank system assessment should address whether such devices are installed and whether they are in proper working order. If a tank system holds materials acutely or chronically toxic by inhalation, it must be designed to prevent emissions into the air.¹⁹

2.9 Disposition of Unfit-for-Use Tank Systems

Immediately remove a tank system from service if it is unfit for use. Remove the waste from the tank system. Remove and dispose of any contamination of the soil and surface water. Any release to the environment must be reported to Ecology immediately.²⁰

¹⁶ WAC [173-303-395 \(1\)\(a\)](#) and WAC [173-303-640\(9\)](#).

¹⁷ WAC [173-303-640\(5\)\(b\)](#).

¹⁸ WAC [173-303-640\(5\)\(a\)](#).

¹⁹ WAC [173-303-640\(5\)\(e\)](#).

²⁰ WAC [173-303-640\(7\)](#).

2.10 Certification of Extensive Repairs

You must repair leaking or unfit-for-use tank systems (by installing an internal liner or repairing a ruptured containment vessel, for example). The repair must be certified by an independent, qualified, registered professional engineer. Certification must include a statement that the repaired tank system can safely handle dangerous waste for the intended life of the system.²¹ Submit the certification to the appropriate Ecology regional office within seven days after placing the tank system back into service.²²

2.11 Integrity Assessment Report for Tank Systems in Current Use

A written report of the tank system integrity assessment must be reviewed and certified by an independent, qualified, registered professional engineer. The certified assessment report must be given to the facility owner/operator. The assessment report and accompanying certification must be maintained with the operating record and kept accessible at the facility.²³

The assessment report must contain:

- A site map of the facility showing the location of the tank system.
- A sketch of the tank system including connected piping and fittings. If there is more than one tank in the system, the individual tanks should be clearly labeled. Locations of specific items inspected should be clearly indicated and cross-referenced in the results of the integrity assessment.
- Results of the structural integrity assessment, including leak testing or other methods used. The results should clearly state whether the tank system has sufficient structural strength and compatibility with the waste being stored or treated.
- An assessment of the wastes to be stored or treated and their compatibility with the tank system.
- An assessment of ancillary equipment, including results of leak testing or other methods used for this assessment.
- Results of the secondary containment assessment.
- Results of the tank system corrosion assessment.
- Results of evaluation of the tank anchoring mechanism.
- Description of the bonding and grounding system in place and an evaluation of its adequacy.
- Description of the spill prevention and overflow prevention controls and an evaluation of whether the equipment is in proper working order.
- Results of the review of the tank venting system.
- A recommended schedule of future tank system integrity assessments "to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail."
- A statement by an independent, qualified, registered professional engineer certifying the results of the integrity assessment. This certification must be according to WAC [173-303-810\(13\)\(a\)](#). The engineer's signature and stamp must be placed below the certification statement.

²¹ WAC [173-303-810\(13\)\(a\)](#).

²² WAC [173-303-640\(7\)\(f\)](#).

²³ WAC [173-303-640\(2\)\(a\)](#).

Design Assessment for New Tank Systems

This section discusses design assessments for new tank systems constructed for storing or treating dangerous wastes. Industry standards and recommended practice codes are discussed in the Appendix.

In WAC [173-303-040](#), a “new tank system” or “new tank component” means a system or component that will be used for storage or treatment of dangerous waste installed after February 3, 1989.

3.1 Tank Structural Integrity

A proposed tank system must be assessed and certified for structural integrity and ability to store and treat dangerous waste. Certification must be conducted by an independent, qualified, registered, professional engineer.

An assessment must show that the foundation, structural support, seams, connections, and pressure controls (if applicable) are adequately designed. It must also show that the tank system has sufficient structural strength, compatibility with the waste(s) to be stored or treated, and corrosion protection to ensure that it will not collapse, rupture, or fail.²⁴

Design Standards

Include structural design standards and criteria from applicable industry standards and recommended practice codes. Clearly indicate design criteria that apply to a specific tank or tank system. If the new tank system being installed includes previously used components, non-destructive examination methods can be utilized to establish their structural integrity (see section 2.1).

Structural Calculations

Provide structural calculations for nonstandard tanks, such as “off specification” or tanks that are field assembled. Structural calculations for standard, shop-fabricated tanks are required if the waste to be stored or treated exceeds the limitations of the manufacturer’s specifications.

Example: If the specific gravity of the waste being stored or treated is greater than the manufacturer’s specifications, shell thickness must be increased. Without an increase in shell thickness, the maximum height of liquid to be stored or treated in the tank must be restricted to the specific gravity of the waste.

Design the tank shell based on a full tank. Calculations should account for liquid specific gravity, external hydrostatic pressure, variables such as internal vapor pressure, and vehicle loading, where applicable. Increase shell thickness to account for an assumed corrosion rate, if needed (see Section 3.6).

Design parameters used in structural calculations should be clearly shown and labeled in sketches. Include seismic considerations that are appropriate to the facility’s seismic risk zone in the structural calculations.

²⁴ WAC [173-303-640\(3\)\(a\)](#).

The foundation underlying the tank system must support the load of a full tank²⁵ plus the secondary containment structure. This includes the weight of the secondary containment structure plus the liquid volume of the largest tank and precipitation from a 25-year storm of 24 hours duration. It must be designed to prevent failure due to settlement, compression, and uplift.²⁶

Design plans should require that homogenous, porous, noncorrosive backfill material be placed below and around tank system foundations and underground piping to provide uniform structural support and prevent excessive settlement.

Anchor the tank system so it will not “collapse, rupture or fail.”²⁷ Special attention must be placed on anchoring to prevent excessive displacement and overturning when tank systems are located less than 500 feet from an earthquake fault. Anchor both underground and in-ground tanks to prevent flotation when installed in saturated zones or in areas subject to flooding.²⁸ Tank systems storing or treating dangerous waste must also be designed to withstand the effects of frost heave.²⁹

Extensive information on structural design criteria for steel tanks, including design criteria for foundations, is included in American Petroleum Institute (API) Standards 620 and 650. Design criteria for concrete tanks are provided in American Concrete Institute (ACI) publication 350 series. Design criteria for reinforced glass-fiber thermoset resin tanks is found in ASTM Standard D4097 and D3299.

3.2 Compatibility of Waste to be Stored or Treated

The tank system must be compatible with the wastes being stored or treated. Do not place dangerous wastes or treatment reagents in a tank system if they can cause the tank system to rupture, leak, corrode, or otherwise fail.³⁰

The design assessment must show that the characteristics of the waste to be stored or treated are compatible with the material properties of the tank system including material properties of any interior lining used. Information on protective measures to prevent chemical attack on concrete structures is contained in the Portland Cement Association publication: *Effects of Substances on Concrete and Guide to Protective Treatments*.

3.3 Pressure Control Systems

A tank system assessment must show that the tank’s pressure control system, if present, is adequately designed.²⁷ Excessive buildup of pressure within a tank can be caused by vapors from fluctuating temperatures or by adding liquid waste into a tank. Maintain internal vapor pressure below the tank's design pressure.

Pressure vacuum valves, pressure relief valves, pilot operated relief valves, and open vents are types of pressure control used on dangerous waste tank systems. Design criteria for tank pressure control systems are provided in API Standard 2000 and NFPA 30.

Consider these items when assessing a tank pressure control system:

²⁵ WAC [173-303-640\(3\)\(a\)\(v\)\(A\)](#).

²⁶ WAC [173-303-640\(4\)\(c\)\(ii\)](#).

²⁷ WAC [173-303-640\(3\)\(a\)](#).

²⁸ WAC [173-303-640\(3\)\(a\)\(v\)\(B\)](#).

²⁹ WAC [173-303-640\(3\)\(a\)\(v\)\(C\)](#).

³⁰ WAC [173-303-640\(5\)\(a\)](#).

- Tank capacity and design pressure.
- Flashpoint and other characteristics of the waste to be stored.
- Maximum inflow and outflow rates.
- Roof type and how it is attached to the tank.
- Locations of pressure relief vents and other pressure controls.
- Discharge location(s) of the pressure control system. (Flammable vapors must be released away from any obstruction and at a sufficient height to prevent accidental ignition.)

Tank systems that store or treat extremely hazardous waste that is toxic when inhaled must be designed to prevent escape of vapors, fumes, or other emissions into the air.³¹ The assessment for these systems should include the design plans and data used to design the required emission control devices.

3.4 Secondary Containment

Secondary containment prevents the release of dangerous waste to the environment. It may be a liner, vault, or double walled tank.³² Piping in the secondary containment is usually in the form of trench liners, jackets, or double walled piping.

All secondary containment systems must:

- Prevent migration of wastes or accumulated liquid from the secondary containment system to the surrounding environment at all times during the operating life of the tank system.
- Detect and collect releases and accumulated liquids. Construction must be of a material that is compatible with the waste to be placed in the tank system.
- Have sufficient strength to withstand stress from static head during a release, climatic conditions, nearby vehicle traffic, and other stresses resulting from daily operations.
- Be placed on a foundation or base that will support the secondary containment system and prevent failure due to excessive settlement, compression, or uplift.
- Have a leak detection system that detects the failure of either the primary or secondary containment structure. It must also detect the presence of released dangerous waste or accumulated liquid in the secondary containment system within 24 hours.
- Be sloped or designed to collect liquids resulting from leaks, spills, or precipitation.

External Liners

External liners are often placed in diked areas and piping trenches to contain any releases from the tank(s) or ancillary equipment. An external liner system must:

- Prevent movement of a release into the surrounding soil.
- Be free of cracks or gaps.
- Contain a release volume equal to the capacity of the tank.
- Prevent run-on or infiltration of precipitation inside the liner. The liner must be able to contain an additional volume of precipitation from a 25-year, 24-hour storm.

³¹ WAC [173-303-640\(5\)\(e\)](#).

³² WAC [173-303-640\(4\)\(d\)](#).

Vaults

Concrete vaults and other concrete structures used for secondary containment are generally designed to allow a visual inspection of the primary tank for leaks. They must also:

- Have an impermeable interior coating or lining that is chemically compatible with the waste to be contained. It must be able to prevent stored waste from migrating into the concrete if a release occurs.
- Have an exterior moisture barrier or other means to prevent moisture from entering the vault.
- Be sized to contain a release equal to 100 percent of the capacity of the largest enclosed tank.
- Prevent run-on or infiltration of precipitation inside the liner or be able to contain precipitation from a 25-year, 24-hour storm.
- Have waterstops at all joints. They should be chemically resistant to the waste to be stored or treated.³³ Materials frequently used for waterstops are polyvinyl chloride (PVC), high and low density polyethylene (HDPE and LDPE), polypropylene (PP), nylon, and various rubber compounds.

Double Walled Tanks

Double walled tanks:

- Must be designed as an integral structure with the inner tank completely enclosed by the outer shell so that any release from the inner tank is entirely contained by the outer shell.
- Must be designed with a built-in continuously operating leak detection system installed between the inner and outer walls, capable of detecting a release within 24 hours (manufacturer-provided leak detection systems are available).
- When made of metal, must have corrosion protection for both the interior surface of the inner tank and the exterior surface of the outer tank.

Buildings Used for Secondary Containment

A building can be used to provide secondary containment if it is designed and installed to meet all of the secondary containment system requirements. The building must prevent run-on, precipitation, and have a sump or other containment method large enough to contain 100 percent of the capacity of the largest tank within its boundary.³⁴ It must also meet the International Fire Code, which requires enough capacity to contain the flow volume of fire protection water calculated to discharge from the fire-extinguishing system over a period of 20 minutes.

The building structure providing secondary containment must also:

- Have an interior coating impermeable to and chemically compatible with the wastes being stored or treated within the building.
- Be designed with an external moisture barrier or other means to prevent moisture from entering the containment area.
- Use waterstops that are chemically compatible with the waste at all construction joints.

Secondary containment is not required for a new tank system if the owner or operator obtains a variance.³⁵

³³ WAC [173-303-640\(4\)\(e\)\(ii\)\(C\)](#).

³⁴ WAC [173-303-640\(4\)\(d\)](#).

³⁵ WAC [173-303-640\(4\)\(g\)](#).

3.5 Ancillary Equipment

Ancillary equipment including piping, fittings, flanges, valves, and pumps require support and protection from excessive settlement, vibration, expansion, or contraction. If ancillary equipment is not inspected daily, it must have secondary containment.³⁶

Identify potential operating stresses early to make sure peak flows and internal stresses are within the piping manufacturer's design limits.

Trench liners, jacketing, or installing double walled piping and fittings are appropriate for secondary containment. It is recommended that one or more emergency shutoffs or check valves be included in the piping to the tank. In the event of rupture or other emergency condition, have replacement backup valves available. Overfill prevention equipment should be installed to warn the operator to shutdown transfer pumps when tank capacity is reached. These can be automatic shutoff controls, liquid level sensing devices, or high level alarms.

3.6 Corrosion

Dangerous waste regulations require a corrosion expert to assess corrosion potential. Protection of the external shell of a metal tank or any external metal component of the tank system must also be assessed. In addition, assessment must include any metal component of the tank system which will be in contact with soil or water.³⁷

The corrosion expert must be certified by the National Association of Corrosion Engineers (NACE) or be an independent, qualified, registered professional engineer who has certification or licensing that includes education and experience in corrosion control on buried or submerged metal piping systems and metal tanks.

Corrosion Potential

When assessing corrosion potential, consider:

- The properties of the surrounding soil, including moisture, pH, resistivity, sulfide, and chloride content.
- The influence of nearby underground metal structures.
- The presence of stray electrical current from nearby equipment using an external power source.
- The structure to soil potential.

Corrosion Protection Measures

A corrosion expert will identify the type and degree of external corrosion protection during the design phase. This is based on the expected use of the tank and its components.³⁸

Protection assessment includes consideration for:

- Portions of the system in direct contact with soil or water. Protection can be corrosion-resistant materials such as fiberglass, reinforced plastic, or a special alloy.

³⁶ WAC [173-303-640\(4\)\(f\)](#).

³⁷ WAC [173-303-640\(3\)\(a\)\(iii\)](#).

³⁸ WAC [173-303-640\(3\)\(a\)\(iii\)\(B\)](#).

- Tank systems partially surrounded by tightly-packed soils with low-oxygen content adjacent to loosely-packed soils with high-oxygen content. Protection can be well-drained, homogenous, crushed rock, or pea gravel for backfill material.
- Other scenarios where a tank and components are in contact with corrosive properties. Protection measures can include corrosion-resistant coatings (such as epoxy, combined with cathodic protection), installing a sacrificial anode, or impressed current cathodic protection system.

Internal corrosion should be prevented, especially when a metallic tank system is designed to store highly corrosive wastes (pH less than or equal to 2 or greater than or equal to 12.5). You can protect from corrosion by increasing the tank shell thickness by a "corrosion allowance," based on a conservative corrosion rate.

Example: a corrosion rate of 0.02 inch per year would require a structural shell thickness to be increased by 1/2 inch, based on a tank design life of 25 years.

You can also use corrosion "coupons" made of the same material as the tank. Coupons are installed to compare the actual corrosion rate to the assumed rate after the tank is placed in service. Periodically measuring thickness with ultrasonic equipment can also help estimate the actual corrosion rate.

3.7 New Tank System Design Assessment Report

Provide a written assessment report indicating the results of the tank system design assessment. The report must be:

- Reviewed and certified by an independent, qualified, registered professional engineer.
- Signed by a corrosion expert (if there are corrosion concerns).

Ecology will use the assessment report and certification to review the tank system design. This is necessary for facilities applying for a final status permit or submitting a permit modification for the addition of a new tank system. The facility should receive a copy of the assessment report with the independent, qualified, registered professional engineer's certification.

The report should contain:

- A site map of the facility showing the proposed location of the tank system within the overall facility.
- A sketch of the tank system including connected piping and fittings. If there is more than one tank in the system, the individual tanks should be clearly labeled.
- Structural design standards and criteria used. Refer to applicable industry standards and recommended practice codes. All calculations for non-standard tanks, foundation design, and any required anchoring should be included.
- An assessment of the dangerous wastes to be stored or treated and their compatibility with the tank system.
- A description and assessment of the pressure control system, if required.
- A description and assessment of the secondary containment system.
- An assessment of the design of ancillary equipment.

- A determination by a corrosion expert of the corrosion potential and corrosion protection requirements for the tank system. The corrosion expert should sign and date this determination.
- A recommended inspection schedule once the tank is placed in service, based on the performance of similarly designed tank systems operating under similar conditions.
- A statement by the professional engineer certifying that the tank system has been adequately designed. This certification must be in accordance with WAC [173-303-810\(13\)\(a\)](#). The independent, qualified, registered professional engineer's signature and stamp must be placed below the certification statement.

3.8 Schedule and Requirements for Conducting Future Integrity Assessments

In order to meet WAC [173-303-640\(3\)\(b\)](#), a schedule for integrity assessments conducted over the life of the tank system will be developed and documented as part of the design and installation assessment for a new tank prepared under WAC [173-303-640\(3\)\(a\)](#). See Chapter 2 of this guide for information on conducting integrity assessments over the life of the tank system.

WAC [173-303-640\(2\)\(c\)](#) can be used as a minimum basis for these subsequent assessments. While the tank system is in service, assessments will be conducted and kept on file per WAC [173-303-640\(3\)\(b\)](#) and [\(h\)](#). All assessments must be certified in accordance with WAC [173-303-810\(13\)\(a\)](#).

Inspecting Tank System Installations

A good tank design will not necessarily ensure proper installation. For this reason, an independent, qualified installation inspector (see definition in WAC [173-303-040](#)) or an independent, qualified, registered professional engineer must inspect a new tank system and components before the tank is covered, enclosed, or used. They must supervise the installation of the tank system. The owner or operator must obtain and keep on file a certification that the tank system was installed properly.³⁹

4.1 Inspection Activities

The quality of the installation is key to the system's integrity. The inspector will look for structural damage or inadequate construction/installation such as weld breaks, punctures, damage to protective coatings, cracks, and corrosion. The inspector must document measures taken to correct these or any other defects discovered. The inspector should document:

- Visual inspection and pressure (soap) testing
- Sub grade and foundation preparation
- Placement and compaction of backfill
- Placement of reinforcing steel and anchor bolts
- Concrete placement
- Placement of shop-fabricated tanks
- Erection of field-erected tanks
- Installation of secondary containment liner or vault
- Installation of piping, pumping, and other ancillary equipment
- Installation of cathodic protection systems
- Tightness testing before placing tank system in service

4.2 Tightness Testing

New tanks and ancillary equipment are required to be tightness tested before being covered, enclosed, or used.⁴⁰ Test above-ground or on-ground tanks at operating pressure using air, an inert gas, or water. Test underground tanks with air before they are placed in the ground or with water after they are placed in the ground.

Piping should be either air tested at 110 percent of the maximum operating pressure or hydrostatically tested at 150 percent of maximum operating pressure. Air or inert gas testing includes pressurizing the interior of the tank or piping and applying a soap solution to the exterior. The person conducting the test then inspects for bubbles, indicating a possible leak, especially at joints and connections.

³⁹ WAC [173-303-640 \(3\) \(c\) and \(h\)](#).

⁴⁰ WAC [173-303-640\(3\)\(e\)](#).

Hydrostatic testing consists of placing water or another nonhazardous liquid inside the tank or piping at the specified pressure and determining if a leak occurs. A leak rate greater than 0.05 gallons per hour is generally considered a "failed" test, indicating the tank or piping system is not tight.

If test results show that the tank or piping system is not tight, the source must be determined. After repairs are made, the tank system must be retested before it is covered, enclosed, or used.

4.3 Field-fabricated Corrosion Protection Systems

Installation of field-fabricated corrosion protection systems must be supervised by an independent corrosion expert to ensure proper installation.⁴¹

4.4 Documentation of Inspection Results

A report documenting the results of the tank system installation inspection must be prepared by an independent, qualified installation inspector or an independent, qualified, registered professional engineer. A copy must be given to the facility owner or operator. This report must accompany the Operating Record and be available at the facility. The report should contain:

- A site plan showing the location of the installed tank system. An as-built site plan should be used, if available.
- An as-built drawing of the installed tank system including connected piping. Individual tanks should be clearly labeled with ID numbers.
- Photographs of each tank installed.
- Inspection notes, photographs, and any other material used to document inspection activities.
- Defects discovered in materials, equipment, or installation procedures and the measures taken to correct these defects (see Section 4.1).
- Tightness testing results that show the tank system is tight before placing it into service (see Section 4.2).
- A statement certifying the proper installation of a field fabricated corrosion protection system. The statement must be signed and dated by the corrosion expert (see Section 4.3).
- A statement certifying the proper installation of the tank system signed and dated by the installation inspector or an independent, qualified, registered, professional engineer.

⁴¹ WAC [173-303-640\(3\)\(g\)](#).

Applicable National Standards and Practice Codes

Here are brief descriptions of industry standards and recommended practice codes that may be helpful for designing or assessing tank systems. These standards are copyrighted and must be purchased or obtained from the publisher. Contact the authoring organization for more information.

American Concrete Institute

ACI Publication 201.1R-08: *Guide for Conducting a Visual Inspection of Concrete in Service*. American Concrete Institute, Farmington Hills, Michigan. Provides a checklist for inspecting concrete structures and includes photographs illustrating various types of concrete cracking and failures.

ACI Publication 224.1R-07: *Causes, Evaluation and Repair of Cracks in Concrete Structures*. American Concrete Institute, Farmington Hills, Michigan. Provides information on causes and methods for repairing cracks in concrete.

ACI Publication 350 *Code Requirements for Environmental Engineering Concrete Structures and Commentary*, American Concrete Institute, Farmington Hills, Michigan. Covers structural design, materials selection and construction of environmental concrete structures.

ACI 350.5-12 *Specifications for Environmental Concrete Structures*. American Concrete Institute, Farmington Hills, Michigan. Covers cast-in-place environmental concrete and shotcrete.

ACI Publication 350.2R-04: *Concrete Structures for Containment of Hazardous Materials*. American Concrete Institute, Farmington Hills, Michigan. Contains design and construction recommendations for reinforced concrete hazardous materials containment systems including reinforced concrete tanks.

American Petroleum Institute

API 570: *Piping Inspection Code - Inspection, Repair, Alteration, and Rerating of In Service Piping Systems Third Edition 11/01/2009*, American Petroleum Institute, Washington, D.C. Provides minimum standards for inspection, alteration, and repair of in-service piping systems.

API 620: *Design and Construction of Large, Welded, Low-Pressure Storage Tanks Twelfth Edition 10/1/2013*, American Petroleum Institute, Washington, D.C. Covers design and construction of welded, field-assembled aboveground steel storage tanks operated from atmospheric pressure through 15 psig.

API 650: *Welded Tanks for Oil Storage Twelfth Edition 03/01/2013*, American Petroleum Institute Standard, Washington, D.C. Provides minimum standards for design, fabrication, erection and testing of vertical, cylindrical, closed and open top welded steel aboveground storage tanks.

API 651: *Cathodic Protection of Aboveground Petroleum Storage Tanks*. American Petroleum Institute Standard, Washington, D.C. Presents procedures and practices for achieving effective corrosion control on aboveground storage tank bottoms through the use of cathodic protection.

API 653: *Tank Inspection, Repair Alteration and Reconstruction. Fourth Edition , Incorporating addendums 2010, 2012, 2013* American Petroleum Institute Standard, Washington, D.C. Provides minimum standards for maintenance, inspection, repair, alteration, relocation, and reconstruction of

non-refrigerated, atmospheric pressure carbon and low-alloy steel aboveground tanks built to API Standard 650.

API 1615: *Installation of Underground Petroleum Storage Systems*. American Petroleum Institute Standard, Washington, D.C. Provides procedures and equipment that should be used for underground petroleum storage systems. Provides guidelines for design and installation of underground piping systems.

API 1632: *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems*. American Petroleum Institute Standard, Washington, D.C. Contains guidelines for providing corrosion protection for below-ground portions of tanks and piping.

API 2000: *Venting Atmospheric and Low Pressure Storage Tanks-Seventh Edition 03/01/2014*. American Petroleum Institute Standard, Washington, D.C. Provides requirements for normal and emergency venting for aboveground tanks and underground refrigerated storage tanks designed to operate from vacuum through 15 psig pressure.

API 2350: *Overflow protection for Petroleum Storage Tanks*. American Petroleum Institute Standard, Washington, D.C. Includes discussion of manual and automatic systems used to prevent tank overfills.

American Society of Mechanical Engineers

ASME B31.3 – 2012: *Process Piping*. Provides minimum requirements for design, fabrication, inspection, and testing of piping systems within a facility engaged in processing or handling chemical products.

ASME B31.4 – 2012: *Pipeline Transportation Systems for Liquids and Slurries*. Provides minimum requirements for design, fabrication, inspection, and testing of piping transporting liquid petroleum products.

American Society for Testing and Materials

ASTM C581 – 03 (Reapproved 2008) *Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service* American Society for Testing and Materials, ASTM International, West Conshohocken, PA. This practice is designed to evaluate, in an unstressed state, the chemical resistance of thermosetting resins used in the fabrication of reinforced thermosetting plastic (RTP) laminates.

ASTM Standard D1998-13 *Standard Specification for Polyethylene Upright Storage Tanks* American Society for Testing and Materials, ASTM International, West Conshohocken, PA. Covers flat-bottom, upright, cylindrical tanks molded from polyethylene capable of containing aggressive chemicals at atmospheric pressure. Tank capacities are from 1900 L (500 gal) up.

ASTM Standard D3299 – 10 *Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks* American Society for Testing and Materials, ASTM International, West Conshohocken, PA. Covers tanks fabricated by filament winding to contain aggressive chemicals at atmospheric pressure and made of a polyester or vinyl ester resin.

ASTM Standard D402186: *Standard Specification for Glass Fiber Reinforced Polyester Underground Petroleum Storage Tanks* American Society for Testing and Materials, ASTM International, West Conshohocken, PA.

ASTM Standard D4097 – 01 (2010) *Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks*. American Society for Testing and Materials,

ASTM International, West Conshohocken, PA. Covers tanks fabricated by contact molding to contain aggressive chemicals at atmospheric pressure, and made of a polyester or vinyl ester resin.

ASTM Standard E2256-13 *Standard Guide for Hydraulic Integrity of New, Repaired, or Reconstructed Aboveground Storage Tank Bottoms for Petroleum Service* American Society for Testing and Materials, ASTM International, West Conshohocken, PA. Covers information about examination procedures and current technologies that can be used to determine the hydraulic integrity of a new, repaired, or reconstructed tank bottom before return to service.

Environmental Protection Agency

530-R-93-005: *Determining the Integrity of Concrete Sumps*. Provides methods for assessing the structural integrity of concrete sumps and vaults storing dangerous waste and information on concrete repair and protective coatings.

530-SW-86-044: *Technical Resource Document for the Storage and Treatment of Hazardous Waste in Tank Systems*. Provides EPA guidance on minimum technical requirements for hazardous waste storage tanks for persons preparing and reviewing Part B permit applications.

International Code Council

2012 International Building Code.

2012 International Fire Code. Contains provisions for the storage and handling of hazardous materials.

National Association of Corrosion Engineers

NACE RP0193-2001: *External Cathodic Protection of On-Grade Metallic Storage Tank Bottoms*. Provides guidelines for the design, installation, and maintenance of cathodic protection systems for the exterior bottoms of on-grade metallic storage tanks.

NACE SP0169-2007: *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*. Contains guidelines for providing and evaluating corrosion control on below-ground metallic piping.

NACE SP0285-2011: *Corrosion Control of Underground Storage Tank Systems by Cathodic Protection*. Contains guidelines for providing and evaluating corrosion protection on below-ground portions of tanks and piping.

National Fire Protection Association

NFPA 30: *Flammable and Combustible Liquids Code*. Contains code provisions for the storage of flammable and combustible liquids in tanks.

Portland Cement Association

IS001: *Effects of Substances on Concrete and Guide to Protective Treatments*. Describes the various types of protective treatments used to protect concrete against chemical attack. Table in publication lists various types of chemicals, their effect on concrete and the recommended treatments to counteract these effects.

Steel Tank Institute

SP001: *Standard for the Inspection of Aboveground Storage Tanks*. 5th Edition.

Standard for Dual Wall Underground Steel Storage Tanks. Addresses the manufacture, inspection and testing of dual wall steel tanks before shipment.

UL (Underwriters Laboratories)

UL 58: *Standard for Steel Underground Tanks for Flammable and Combustible Liquids.* Provides requirements for shop-fabricated horizontal atmospheric-type cylindrical steel tanks for underground storage of flammable and combustible liquids.

UL 142: *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.* Provides requirements for shop-fabricated horizontal and vertical welded steel tanks for aboveground storage of stable, noncorrosive liquids with a specific gravity less than or equal to water.

UL 1316: *Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures.*