

New Jersey Department of Environmental Protection

Bureau of Release Prevention

A Guide to the Inspection and Testing of Aboveground Storage Tanks

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This document supersedes the September 2001, April 2007, May 2010, and March 2014 editions of “A Guide to the Inspection and Testing of Aboveground Storage Tanks” and the April 1999 edition of “A Guide to the Implementation of API 653 Tank Inspection, Repair, Alteration and Reconstruction”

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Introduction

N.J.A.C. 7:1E, “Discharges of Petroleum and Other Hazardous Substances” (DPHS), specifies testing and inspection requirements for aboveground storage tanks over 2,000 gallons in capacity which contain hazardous substances identified pursuant to N.J.A.C. 7:1E-1.7. These standards apply to major facilities as defined at N.J.A.C. 7:1E-1.6. They are implemented by the Bureau of Release Prevention (Bureau).

The tank testing and inspection requirements formerly found at N.J.A.C. 7:1E-2.2(a) were revised in their entirety, effective February 27, 2007, and are now located at N.J.A.C. 7:1E-2.16. The purpose of this guidance is to assist the regulated community in compliance with N.J.A.C. 7:1E-2.16.

Storage tanks at some facilities have measures alternative to the regulatory requirements that were approved under the provisions of N.J.A.C. 7:1E-1.11(e). Pursuant to N.J.A.C. 7:1E-4.9(b), as a part of the plan renewal, the owner or operator of the facility either submits a certification that alternative measures pursuant to N.J.A.C. 7:1E-1.11(e), such as tank integrity testing methods or intervals being used for a particular tank, achieve compliance with the current requirements of N.J.A.C. 7:1E, or else submits revisions to the plan. The Department of Environmental Protection (Department) evaluates the submitted information as a part of the review of the plan renewal, taking into consideration the original reasons for granting alternative measures as well as the results of any recently completed inspections. In addition, N.J.A.C. 7:1E-2.16(i) establishes that an owner or operator can propose a protocol for testing to the Department for approval.

Various industry-developed standards have been incorporated by reference into N.J.A.C. 7:1E-2.16. This document describes those standards, as well as state-defined testing protocols, along with their application to various types of tanks. The Appendix provides web links to where these standards can be obtained. The Department does not provide copies of these standards.

This guide has been prepared to assist the regulated community in selecting a method of integrity testing that will demonstrate compliance with the rules. Mention of any trade name or commercial product in this document does not constitute an endorsement of the product by the Department.

Any questions regarding the inspection and testing of aboveground storage tanks may be directed to the Bureau of Release Prevention, NJDEP, PO Box 420, Mail Code 22-03D, Trenton, NJ 08625-0420 or by telephone at (609) 633-0610.

Testing New Tanks and Tanks Entering Hazardous Substance Service

N.J.A.C. 7:1E-2.16(b) requires that any aboveground storage tank over 2,000 gallons in capacity installed or placed into service on or after July 22, 1990, be subject to integrity testing prior to being placed into service for hazardous substance storage. This includes tanks newly installed or relocated on-site, regardless of the material(s) of construction.

New field-erected storage tanks must be tested in accordance with the standard used for their construction. For example, American Petroleum Institute (API) Standard 650, “Welded Steel Tanks for Oil Storage” and API 620, “Design and Construction of Large, Welded, Low-Pressure Storage Tanks”, include testing procedures to be used upon completion of construction.

Existing storage tanks that were not in hazardous substance service but are going to be brought into hazardous substance service must be tested in accordance with the applicable protocol contained in N.J.A.C. 7:1E-2.16, described in the “Subsequent Testing” section of this document.

Shop-built storage tanks typically undergo testing by the manufacturer at the site of fabrication based on the standard to which the tank was manufactured; for example, Underwriters Laboratory (UL) Standard 142, “Steel Aboveground Tanks for Flammable and Combustible Liquids”. In addition, shop-built storage tanks must be tested after installation on site, including relocating a tank on-site, to ensure continued integrity of the tank and of all connections to it, using a test such as a pneumatic or static head test.

The static head test measures the stability of a volume of liquid in a tank filled to at least 75% capacity and held over a minimum period of 24 hours. If temperature fluctuations are likely to occur, as when a tank is outdoors, a volume correction factor is required to determine the standardized adjusted volume at 60 degrees Fahrenheit; the correction factor is calculated in accordance with the API Manual of Petroleum Measurement Standards. If the beginning and ending temperature-adjusted level readings are within 0.2% of each other and no abnormal conditions are observed, the newly installed or reinstalled shop-built tank has successfully passed the static head test. Modifications to this procedure may also be acceptable; contact the Bureau for review and approval of any modification prior to implementation.

Pneumatic testing is inherently more hazardous than static testing with a liquid, and precautions should be taken to protect personnel and adjacent property if this method is chosen. API Standard 650 and ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2, contain procedures for properly conducting a pneumatic test. The Steel Tank Institute’s (STI) recommended practice, R912 “Shop Fabricated Stationary Aboveground Storage Tanks for Flammable, Combustible Liquids - Installation Instructions” also contains air pressure test procedures for single- and double-walled tanks.

Any tank that becomes subject to N.J.A.C. 7:1E as a result of regulatory changes or as result of changes at a facility, such as increased storage capacity, must undergo integrity testing immediately upon entering the DPHS program as described in the “Subsequent Testing” section of this document.

Subsequent Testing

Subsequent testing must be performed as specified under N.J.A.C. 7:1E-2.16(d) through (i); the testing to be performed depends on the material of construction of the tank and whether the tank is shop-built or field-erected.

All tanks under any testing protocol

During an external or internal visual inspection required under any of the testing protocols, the tank inspector looks for signs that may indicate threatened structural integrity. These are based on the tank's material of construction and may include but are not limited to, cracks, discoloration, staining, leaks, corrosion, erosion, settlement, delamination, and deformation. The external inspection must include inspection of the support structures and appurtenances.

As appropriate or required by the standard used, a qualified professional engineer, API certified inspector, or STI certified inspector reviews the results of integrity tests and internal visual inspections to ensure the tank is fit for service. If the integrity test or internal inspection results indicate significant deterioration of structural strength or other signs that the tank is not sound, the tank must be emptied and either be repaired or removed from service as stated at N.J.A.C. 7:1E-2.16(j).

If none of the outlined protocols for integrity testing are found to be applicable for a particular tank, an alternate protocol may be proposed to the Department. If an alternate method of integrity testing will be used for a particular tank under the provisions of N.J.A.C. 7:1E-2.16(i) and 1.11(e), this method must be clearly described in the facility's approved Discharge Prevention, Containment, and Countermeasures (DPCC) plan prior to implementation. An explanation as to why none of the outlined protocols is practicable must be included in the plan.

Silos holding hazardous substances that are solids must undergo integrity testing under the provisions of N.J.A.C. 7:1E-2.16(i) as explained above.

It is important to note that the date of subsequent testing is based on the date of the last test or inspection, not on the date that the tank was placed back into service or the date that the inspection report was issued. **In addition, inspections must be conducted as scheduled pursuant to the applicable protocol for tanks that are empty but not out of service per the definition found at N.J.A.C. 7:1E-1.6.** If there are any questions or concerns regarding this matter, please contact the Bureau.

Field-erected steel aboveground storage tanks operated at atmospheric pressure

Field-erected steel aboveground storage tanks operated at atmospheric pressure must follow an inspection and maintenance program that is in compliance with the most current edition of API Standard 653 (API 653), "Tank Inspection, Repair, Alteration and Reconstruction". However, similar service and risk based inspection scheduling described in API 653 are not permitted. The inspection schedule for each tank must be included in the facility's DPCC plan.

API 653 is a maintenance and inspection program adopted and revised by the American Petroleum

Institute to provide for an ongoing assessment of a facility's storage tanks. A facility must follow all of the procedures for maintenance and inspections outlined in the API 653 standard and perform any repairs recommended by the authorized inspector in order to use API 653 to show compliance with the integrity testing requirements of N.J.A.C. 7:1E-2.16. The four major components of the integrity testing portion of API 653 are as follows:

- Routine (Monthly) In-service Inspection,
- External Inspection,
- Ultrasonic Thickness Inspection, and
- Internal Inspection.

All recommendations noted by the authorized inspector or contained in the inspection report must be addressed according to API 653 standards. These findings and repairs must be documented as specified by API 653.

DPCC plans for some facilities have indicated that internal inspection is not required under API 653 if the tank is horizontal, raised on saddles. API 653 section 6.5 states, "in cases where construction, size, or other aspects allow external access to the tank bottom to determine bottom thickness, an external inspection in lieu of an internal inspection is allowed to meet the data requirements of Table 4.4 [bottom plate minimum thickness]. However, in these cases, consideration of other maintenance items may dictate internal inspection intervals." Therefore, API 653 does not give a blanket waiver from internal inspections for such tanks. Instead, each tank is reviewed individually by the API 653 authorized inspector to determine whether an internal inspection is required, and if so, at what interval.

Please note that simply testing a tank using techniques described in API 653 is not equivalent to having an inspection and maintenance program that is in compliance with API 653; ultrasonic thickness (UT) tests performed to "API 653 standards" does not establish that a storage tank is in full compliance with API 653. It merely states that the procedures for performing that test were conducted following the protocol for UT testing contained in API 653.

Field-erected steel aboveground storage tanks operated under pressure

Field-erected steel aboveground storage tanks operated under pressure must follow API 510, "Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair, and Alteration". This includes tanks containing liquids as well as tanks containing gases that are hazardous substances including, but not limited to, anhydrous ammonia and chlorine.

Please note that if a tank was constructed as a pressure vessel but is operated at atmospheric pressure, N.J.A.C. 7:1E-2.16(d) does not allow the use of API 510.

API 510 is a maintenance inspection, rating, repair and alteration standard for pressure vessels. It is applicable to vessels constructed and maintained in accordance with ASME Section VIII or other recognized pressure vessel codes. Facilities following the API 510 inspection standard must follow all aspects of the current edition of the code. This includes, but is not limited to, maintenance, repair, alteration and inspection of these tanks.

The major components of the integrity testing portion of API 510 are

- External inspection and
- Internal inspection.
- On-stream inspections can be substituted for internal inspections at the recommendation of an authorized inspector if all requirements are met. The justification for on-stream inspection must be documented as part of the inspection.

All recommendations noted by the authorized inspector or contained in the inspection report must be addressed according to API 510 standards. These findings and repairs must be documented as specified by API 510.

Shop-built steel aboveground storage tanks

Shop-built steel aboveground storage tanks operated at atmospheric pressure must follow an inspection and maintenance program that is in compliance with the current edition of either API 653 or the STI standard SP001, “Standard for The Inspection of Aboveground Storage Tanks”. For shop-built steel aboveground storage tanks operated under pressure, the owner or operator may propose an appropriate integrity testing protocol to the Department in accordance with N.J.A.C. 7:1E-2.16(i) and 1.11(e); API 510 may be applicable to these types of tanks.

STI SP001 is applicable to double-walled storage tanks as well as to single-walled tanks. API 653 is not applicable to double-walled storage tanks.

STI SP001 requires owners to establish the inspection criteria utilizing the information and tables in Section 5 of the standard. The inspection schedule for each tank must be included in the facility’s DPCC plan. STI SP001 requires periodic AST inspections for all tanks regardless of tank size and configuration; other components may or may not be applicable to a particular tank.

Please note, when determining the category of a tank, the Department does not consider an aboveground storage tank on a concrete base without tell-tales or some other form of leak detection to meet the definition of Continuous Release Detection Monitoring (CRDM). For a tank to be deemed a category 1 tank, the means used to achieve spill control and CRDM must be independent of each other.

The components of the integrity testing portion of STI SP001 for a particular tank are dependent on the size and category of the tank. The major components are as follows:

- Periodic AST Inspection,
- Formal External Inspection,
- Formal Internal Inspection, and
- Leak Test.

The Periodic AST Inspection consists of both Monthly and Annual Inspections. Checklists for each tank must be completed and retained. The AST Record must be filled out and maintained on site for each tank. These documents are provided in Appendix C of STI SP001. It is important to note that STI SP001 specifies that these documents must be retained for 36 months from the inspection date. However, N.J.A.C. 7:1E-2.15(d) requires that records of integrity testing, inspection, and repair must be maintained for the lifetime of the tank. Therefore, the STI SP001 36 month timeframe does not

meet the purposes of this program.

Fiberglass reinforced plastic (FRP) aboveground storage tanks

FRP aboveground storage tanks must undergo integrity testing every five (5) years consisting of acoustic emission testing, in accordance with ASTM International (ASTM) Standard E1067, “Standard Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels”, in combination with internal and external inspections of the tank and all appurtenant structures by an experienced, qualified inspector.

ASTM E1067 is a standard practice for the acoustic emission examination of FRP tanks and applies to both new and in-service equipment. The current version of ASTM E1067 must be used.

Homogenous plastic tanks

Homogenous plastic tanks must undergo integrity testing every five (5) years consisting of internal and external visual inspections of the tank and all appurtenant structures by an experienced, qualified inspector.

Other integrity testing options

If a particular tank does not fall into one of the established categories for which a specific testing protocol is mandated or if an alternative to the established integrity testing protocol is otherwise necessary, integrity testing may be performed every five (5) years that includes the following:

- a shell thickness test,
- a bottom thickness test,
- a visual inspection of the tank exterior, and
- a visual inspection of the foundation and ancillary equipment.

The shell thickness test and bottom thickness test must be performed to a standard such as ASME Boiler and Pressure Vessel Code, Section V “Nondestructive Examination” and must be capable of detecting corrosion, erosion or other wall or bottom thinning to less than a predetermined thickness to ensure sufficient structural strength. At the time of a bottom thickness test done from the tank interior, a visual inspection of the tank interior looking for cracks and similar problems should also be performed.

Owners or operators following this option should not expect that any aspect of the inspection program, including the bottom thickness test, would be granted any extension beyond the regulatory requirement of five years.

If a tank is on legs or saddles such that thickness tests can be performed on the entire tank from the outside, tank entry may not be required. However, if the tank bottom is on the ground or otherwise not accessible from the outside of the tank, the bottom thickness test will need to be performed from inside the tank. Robotic, rather than human, tank entry is acceptable if the tank size, configuration, and contents allow for this option.

Transitioning Between Testing Protocols

If an owner or operator decides to change a tank's inspection and testing protocol, he or she must first obtain approval in the form of a Plan Amendment or a Plan Renewal prior to implementing the new integrity testing protocol. A baseline set of inspections must be established in the DPCC plan.

The following are some examples of transitioning between integrity testing protocols.

Five year program or API 653 to STI SP001:

- Next Formal External Inspection date must be based on the last shell UT test date.
- Next Leak test date must be based on the last Leak test date (e.g. static head test or acoustic emission test).
- Next Internal Inspection date must be based on the last Internal Inspection date.
- If no prior UT test, Leak test or Internal Inspection was performed, a baseline must be established and indicated in the DPCC plan.
- Monthly and Annual Periodic Inspections must begin immediately upon approval of the Plan Amendment or Plan Renewal.

Five year program to API 653:

- Performance of the Routine (Monthly) In-service inspection must begin immediately upon approval of the Plan Amendment or Plan Renewal.
- External Inspection must be conducted within five (5) years of the previous External Inspection date.
- Ultrasonic Thickness Inspection must be conducted within five (5) years of the date of the previous UT inspection of tank shell.
- Internal Inspection must be conducted within ten (10) years of the previous UT testing date of the tank bottom.

Alternative program to a protocol listed in N.J.A.C. 7:1E-2.16(d) through (g):

- Inspection dates for UT testing of the tank shell and tank bottom, if applicable, must be five (5) years from the previous UT inspection of tank shell or tank bottom.
- Acoustic Emission testing, if applicable, must be conducted within five (5) years of the previous Acoustic Emission test.
- External Inspection of the tank, if applicable, must be conducted within five (5) years from the previous External Inspection.
- Internal inspection of the tank, if applicable, must be conducted within five (5) years from the previous internal inspection.

What needs to go in a DPCC Plan

To meet the requirement for a schedule of integrity testing in the DPCC plan, for all testing protocols, the month and year of the last completed and next scheduled inspections for each individual tank must be provided for each type of required test.

If a tank has been transitioned from one inspection protocol to another, the dates for all inspections that were performed under the previous protocol must continue to remain in the plan until the next plan renewal or until one full inspection cycle has been completed.

It is strongly recommended that a table be utilized to clearly present the integrity testing schedule.

API 653 Protocol

The following information and testing dates must be provided:

- The monthly Routine In-service Inspection must be included as a part of the description of the integrity testing protocol, individual dates are not required,
- External Inspection,
- Ultrasonic Thickness Inspection, and
- Internal Inspection.

If any of these tests will always be combined and performed on the same date, make this clear in the plan.

API 510 Protocol

The following information and testing dates must be provided:

- External inspection,
- Internal or on-stream inspection, and
- If the tank is constructed as a pressure vessel but is not being used as a pressure vessel, then a justification must be included in the plan for using API 510.

STI SP001 Protocol

The following information and testing dates must be provided:

- The category (category 1, 2, or 3) that the tank(s) falls into under STI SP001 must be included in the plan because that is the basis for the particular tank inspections and frequency of inspection to be performed,
- The justification for determining that a tank is in a particular category must also be included in the plan,
- The plan must clearly state that an STI SP001 Monthly Inspection Checklist will be completed monthly for each tank,
- The plan must state the month in which the Annual Inspection will be performed each year, and
- Include the dates for the Formal External Inspection, Leak Test, or Internal Inspection, as required.

Protocol for FRP Tanks

The plan must clearly show the following testing dates:

- Acoustic emission (ASTM E1067) test,
- Internal visual inspection, and
- External visual inspection, including appurtenant structures.

Protocol for Homogeneous Plastic Tanks

The plan must clearly show the following testing dates:

- Internal visual inspection, and
- External visual inspection, including appurtenant structures.

Five Year Testing Protocol under N.J.A.C. 7:1E-2.16(h)

The plan must clearly show the testing dates for the following items:

- Tank shell ultrasonic thickness,
- Tank bottom ultrasonic thickness, and
- Visual inspection of tank exterior, foundation and ancillary equipment, e.g. pipes and valves.

Alternative Protocol under N.J.A.C. 7:1E-2.16(i)

The plan must clearly show the schedule for performance of all tests and inspections. In addition, include in the plan the justification as to why none of the protocols for integrity testing outlined in N.J.A.C. 7:1E-2.16(d) through (h) are practicable for that particular storage tank.

Integrity Test Reports and Checklists

The integrity test report or checklist, which must be kept for the lifetime of the tank, should consist of the following components:

- The name of the major facility
- Tank identification
- Test method used
- Date of the test or inspection
- Results, including data, calculations, and the date of the next test, as applicable
- Recommendations, including any that necessitate immediate action
- Name and affiliation of the person(s) that prepared the report
- Inspector's qualifications, as applicable.

Report formats are provided in API 653 and STI SP001 and are acceptable as long as the above information is included in the report. Checklists, where applicable, must be completed and retained for each tank.

Again, it is important to note that STI SP001 specifies that the checklists must be retained for 36 months from the inspection date. However, N.J.A.C. 7:1E-2.15(d) requires that records of integrity testing, inspection, and repair must be maintained for the lifetime of the tank. Therefore, that 36 month timeframe must be disregarded for the purposes of this program.

Appendix

Web links for organizations mentioned in this guidance document

American Petroleum Institute

www.api.org

American Society of Mechanical Engineers

www.asme.org

Underwriters Laboratories

www.ul.com

Steel Tank Institute

www.steeltank.com

ASTM International (originally known as the American Society for Testing and Materials)

www.astm.org