

INTEGRITY INSPECTION OF ABOVE GROUND STORAGE TANKS

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ABSTRACT

40 CFR 112.7 requires integrity inspection of containers subject to this regulation. Where applicable, inspection to a nationally recognized standard is required. Where there is no standard, good engineering judgment is allowed. This paper discusses commonly used national standards for inspection and methods of implementing common and less common inspection strategies. It gives owner/operators information on the required inspections to enable them to know what type of inspection is available or required. It is not intended to give complete instructions on how to conduct the required inspections.

KEY WORDS

Integrity inspection, American Petroleum Institute (API), Steel Tank Institute (STI), Magnetic Flux Leakage (MFL), Ultrasonic Testing (UT), National Fire Protection Association (NFPA).

WHAT IS AN INTEGRITY INSPECTION

An integrity inspection of a container(s) is a system designed to be sure that a container would not fail under normal operating conditions. In this application, it generally consists of three sections; frequent recorded visual inspections, less frequent rigorous external inspections and frequently, an internal inspection.

WHO PERFORMS INTEGRITY INSPECTIONS?

There are three groups of people involved in performing inspections. They are owner/operator personnel; STI certified inspectors and/or API authorized inspectors. In general, owner/operator personnel perform monthly, quarterly, annual and some longer-term inspections as required by the SPCC plan or the chosen national standard. They must be knowledgeable about tanks and the products stored in the tanks. STI certified inspectors perform longer-term inspections using STI criteria. API authorized inspectors do longer-term inspections under both API and STI criteria. Both API and STI inspectors require specialized training and passing a test to gain their certification. API and STI inspectors can be employees of the owner/operator who are duly trained and certified, unless non-employee status is required by the regulatory jurisdiction. The use of these groups of people will become more obvious further in the paper.

SMALLER UNITS; PINTS, QUARTS, GALLONS, PAILS, KEGS

All items less than 55 gallons do not require integrity testing, regardless of the number of containers.



Some examples of smaller packaged petroleum items that do not require integrity inspection.

55-GALLON DRUMS

There is no nationally recognized standard for integrity testing of this size and style of container. In this area good engineering judgment is allowed. One method that is used is to be sure to include storage and use areas for these containers in a visual inspection plan. Depending upon the number of drums and their area density, they could be included in the monthly-recorded inspections required under STI or API inspection requirements. If there is a main storage location for drums, maybe a daily or weekly sign-in sheet that someone checked the location to be sure that there are no leaking drums. The design of the plan should also take into account items such as containment capabilities. Better containment may mean less frequent recorded inspections. Single drums being used in a given location could sit on a containment skid. It has been successfully argued that a single drum rupture inside a properly sized facility with no floor drains cannot reach any location to do environmental damage. This does require adequate, readily available spill clean-up capabilities.



These are the smallest containers that require an integrity inspection under SPCC regulations.

UL-80 TANKS, 275, 330, 550, 660 GALLONS

These tanks are usually recognized as home heating oil style tanks. However, they do find uses in industrial applications. Prior to the latest version of SP001-05, some plans were written that assigned a life to the tank, usually 20 years. The plans were written so that the tank would be replaced at the end of the assigned life. This was usually cheaper than having the tanks inspected by a certified inspector every 5 years. This method of handling the required tank integrity issue has changed with the issuance of the latest SP001-05 standard.



Yes, these tanks are seen in industrial service!



UL-142 TANKS, NON-DOT TOTES; STI INSPECTIONS

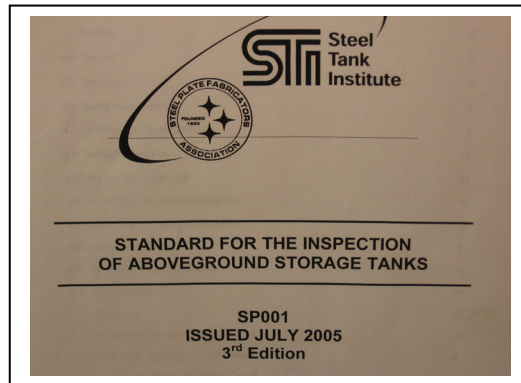
These are the most common storage tanks in use today. They are tanks that are fabricated by a tank manufacturer and are delivered complete to your site, usually by truck. Complete does not include appurtenances like valves, gauging systems, vents, etc. This includes horizontal and vertical tanks, single and double wall. Tanks supported on legs are also included. Totes not used in commerce also require inspection and can be done under this protocol. (Totes used in commerce require inspection to DOT specifications.)



These totes and tanks can be inspected using SP001

The Steel Tank Institute (STI) has created a tank inspection standard that is recognized nationally. It is recognized by EPA as a legitimate integrity inspection protocol. The standard is

known as SP001-05. The –05 on the end denotes the year of issuance of the latest standard. By the time that this paper is presented, there may be a newer standard –06. The current –05 and proposed –06 are new protocols that substantially change the methodology for inspecting these tanks. Ordinarily, standards do not change on a yearly basis, but the –05 was a new protocol and the -06 is being issued to improve some minor issues. If you began an integrity inspection program prior to the beginning of the new SPCC plans, it may be worth your time to update the program to the newer STI standard.



The STI standard divides tanks inspected under the standard in to several categories. The categories include sizes and styles. Sizes include 0-1,100 gallons, 1,001 to 5,000 gallons, 5,001 to 30,000 gallons and over 30,000 gallons. Styles include tanks supported off the floor, vertical and horizontal, tanks with Release Prevention Barriers and tanks with Leak Detection.

The use of this standard also demands a commitment to follow not only major inspections, but to also perform the owner/operator monthly, quarterly and annual inspections as required by the standard. Depending upon the size and configuration of the tank, this may also include 5, 10 and 20-year inspections. As you will see when you look at the standard, some tanks never require an inspection by a certified inspector. If you have a tank problem under these circumstances, and your records are not up-to-date, you will be operating in violation of your SPCC plan.

There is one exception to the shop built tank applicability stated above. Field erected tanks up to 30' in diameter can be inspected using the STI standard. There is a special section of the STI standard dealing with this type of inspection.



This 30'Ø tank can be inspected using SP001.

Tanks on saddles or legs where the bottom is accessible can be entirely inspected from the outside of the tank using ultrasonic testing (UT). This is completely legal. However, experienced inspectors know that tanks generally fail by pitting. It is very rare and to find a pit with UT inspection. It is also generally recognized that UL-142 tanks do not fail catastrophically and that the regular inspections required by this standard should find leaks before they become serious. Tanks that are on saddles or legs that require an inspection to meet SPCC regulations can be inspected by the external visual and UT method. If there is a question about the true condition of a tank, ex. a sale or purchase or a long time in-service, an internal inspection should be performed.

SP001 offers an alternative inspection for leak integrity. It is a pressure test of the tank. The standard carefully states that the tank must be thoroughly cleaned prior to the pressure test and that compressed air should not be used to test tanks that have been in service. This is a safety requirement.



Tanks on legs, concrete encased tanks and double walled tanks are inspected using SP001.

The general concept behind the STI inspection intervals is one of risk management. From the chart in the SP001 standard, it will be seen that the smaller a tank is, the less frequently or less rigorous is the inspection. Also, the more safeguards that the tank has for pollution prevention, the less frequent and less rigorous is the inspection. This is because the smaller the potential spill and the more anti-pollution precautions that have been taken, the less likely is a serious, uncontrolled spill. This is why the SPCC regulations exist.

WHAT TO EXPECT FROM A STI TANK INSPECTION?

The SP001 has forms that can be used for the monthly and annual owner/operator inspections. Using these forms as a base, a company can make their own forms. Some companies put their forms on a PDA (Palm, Blackberry, Sony, etc). After completion, they are downloaded onto a computer for long-term storage. Owner /operator inspections are required to be kept for 3 years.

Inspectors providing formal external and/or formal internal inspections should issue a report that includes the checklists required by SP001, any data, any analysis of data and required or recommended repairs. Required repairs are those required by the standard or those that will

affect the structural integrity of the tank until the time that the next similar inspection is required. Also, relevant drawings and pictures are often included. Inspections performed by API or STI certified inspectors are required to be kept for the life of the tank.

FIELD FABRICATED TANKS, API-653 INSPECTIONS



Field fabricated tanks are tanks that were delivered to the worksite in pieces, usually flat or rolled. Some minor pieces may be assembled such as manholes or nozzles. The tanks are usually built to American Petroleum Institute (API) standards. Older tanks may have not been constructed to a particular standard, but they can be inspected using the API-653 inspection standard.



This riveted tank and larger welded tanks are inspected using API-653.

API-653 is the standard by which these tanks are inspected. As with the STI standard, owner/operator inspections are required along with inspections by an Authorized Inspector. The standard is much larger and more comprehensive than the STI standard. The tanks covered by the standard are larger and present larger risks than the tanks covered by the STI standard. Prior to the advent of the STI standard in 2000, all steel aboveground tanks were inspected using the API-653 standard.

API-653 standard requires routine, In-service and Out-of-service inspections. A routine inspection is a monthly recorded inspection by the owner/operator. An In-service inspection is

an inspection by an Authorized Inspector of the outside of the tank while the tank remains in-service. This usually includes a thorough visual inspection of the tank along with ultrasonic testing (UT) and level measurements. These inspections are required every five years or less, depending upon inspection findings.

Out-of-Service inspection involves emptying and cleaning the tank so that it can be inspected internally. In general, Out-of-Service inspections are required at a maximum time interval of 20 years. However, it is also required that the corrosion rate of the floor be determined within ten years of the floor installation. This frequently involves the cleaning of the tank for an internal inspection to determine the corrosion rate. When the corrosion rate is known and required repairs are completed, the next Out-of-Service time interval is calculated.

When the tank is emptied and cleaned, the amount of corrosion is partially determined by measuring the depth of pits on the floor topside. Floors also corrode from the underside. There are several methods of determining the depth of underside pitting. The most popular method is Magnetic Flux Leakage (MFL) testing with UT follow-up. This method allows the floor to be scanned (up to 97% of the floor can be covered). Areas indicating a problem are further inspected using UT methods. It is widely agreed that tank floors fail mostly by pitting. This method helps to find significant under floor pitting. Combining the floor topside and underside corrosion rates gives the corrosion rate, which is then used to determine the next inspection interval as mentioned above.



One type of MFL machine for floor scanning. Note: Internal floating roof.

There are other methods of determining floor corrosion rates. Statistical analysis of random floor thickness readings is sometimes used. The random numbers can be gotten after the tank is cleaned. There is a method that places a robot into the tank and gets the random UT readings while the tank is in-service. Eddy current testing is another floor inspection method that is becoming more popular.

WHAT TO EXPECT FROM AN API-653 TANK INSPECTION?

API-653 requires the authorized inspector to be on-site for the inspection to qualify as an API inspection. This is not necessarily at the same time as the data is gathered. The API inspection is more rigorous because the structures are larger and more things can and do go wrong. The inspection report is usually larger and in more detail than the STI report. It usually includes an

inspection narrative with required and recommended repairs; the API-653 checklist; calculations and data including UT data, level survey and analysis, results of magnetic particle testing, if necessary, MFL report, floor thickness calculations for remaining life and repair thicknesses; photographs and drawings.

ALTERNATIVE INSPECTION METHODS

API-653 allows alternative inspection methods. However, these methods are not allowed by all jurisdictions. They are Similar Service and Risk Based Inspection (RBI). Similar service is becoming a questionable inspection method and is not accepted by some regulators. RBI is very expensive to do because it involves finding someone who has the credentials to perform the analysis. It works best in a situation where there are many larger tanks to be inspected. As mentioned previously, the SP001 inspection matrix does involve some risk-based concepts. Field fabricated tanks involve larger risks so the analysis is more critical and requires individual attention.

BRITTLE FRACTURE

Brittle fracture is the complete, almost instantaneous failure of a tank. It occurs when the steel in the tank is not tough enough to resist tearing when there is a flaw in the steel. It only occurs in field-fabricated tanks originally built before 1980. (Steel toughness requirements changed to increase toughness in that year.) Consideration of brittle fracture is required when a change in service to more severe service or when significant repairs have been performed on a subject tank. Tanks that remain in the same service for a long period of time do not require brittle fracture analysis by SPCC regulations. A tank with a bottom shell course thicker than 0.5” that goes from #6 oil (heated) to #2 oil (unheated), a change to more severe service, does require a brittle fracture analysis. There are some regulatory authorities making companies do a brittle fracture analysis on all subject tanks and forcing hydrostatic testing if the paper analysis fails.

UNDERGROUND, NON-EPA OR STATE REGULATED TANKS

If there are underground oil tanks on your property that are not regulated by EPA underground storage tank regulations or State regulations comparable to the EPA regulations, these tanks are included in the SPCC regulations and require integrity testing. When the inspection strategy for these tanks is included in the SPCC Plan, it should follow the same logic as regulated tanks when specifying the integrity testing plan. This could include length of time between inspections, leak detection, spill containment and inventory reconciliation. There are several EPA approved systems that can be used to integrity test an underground tank. The inspections performed by outside testing agencies are required to be kept for the life of the tank.

MISCELLANEOUS

Frequently, tank integrity inspections cover more than just the tank itself. There are physical aspects of the tank system that may be inspected. This may include the following:

- Piping – This includes minimal UT measurements of pipe thickness, when available, and a good visual inspection looking for likely signs that could cause a problem. This only covers pipe in the vicinity of the tank. When the pipe goes through a wall or out of the containment area or substantially away from the tank, the pipe inspection is complete unless otherwise requested.
- Containment – It is not the job of the inspector to determine if the containment is adequately sized or impervious. However, he should note if there are obvious problems such as trees growing near the tanks, washouts, etc. This should not be considered a containment inspection, unless a more thorough containment inspection is requested by the customer.
- Ancillary Equipment – This includes items on or attached to the tank. This could be overfill alarms, gauging equipment, thermometers, etc. The absence of required items should be reported. Unless otherwise specified, it is not the job of the inspector to ascertain that the electronic equipment on the tank is properly functioning unless it is damaged or missing from the tank.
- Other standards – The most notable other standard affecting tanks is National Fire Protection Association (NFPA) 30. There are some limited items in the standard on which the inspector may wish to comment. These would usually include valves, alarms, etc. An integrity inspection should not be construed as a compliance report for NFPA 30.

SUMMARY

Integrity testing of items without a national standard, like drums and underground tanks, can be planned by the person writing the SPCC plan. Nationally recognized standards, STI and API, both require regular external inspections by owner/operator personnel. For STI, the inspections are monthly, quarterly and annually. In some limited instances, that may be all that is required. For API, owner/operator recorded inspections are required on a monthly basis.

STI requires inspections by a certified inspector at maximum intervals and types as shown in the table. Depending upon results, lesser time intervals may be assigned.

API requires external inspections by an authorized inspector every five years. Initial internal inspection is required by ten years after the floor is installed. Thereafter, up to twenty years between inspections is allowed depending upon inspection results and repairs.

Note: Items in this paper that reference a particular standard are not the opinions of the publishing organizations or a complete statement of the standard so referenced. They are the

opinion of the author who is a certified inspector. The standards may be obtained from the listed references.

REFERENCES

API Standard 653 Tank Inspection, Repair, Alteration and Reconstruction, American Petroleum Institute, 1220 L Street, N.W. Washington, DC 20005

NFPA 30 Flammable and Combustible Liquids Code, National Fire Protection Association, 1 Batterymarsh Park, Quincy, MA 02169

SP001 Standard for the Inspection of Aboveground Storage Tanks, Steel Tank Institute, 570 Oakwood Road, Lake Zurich, IL 60047

Tank Inspection Based Upon Risks to the Environment, Dana C. Schmidt, PE, Steel Tank Institute, presented at the Sixth Biennial Freshwater Spills Symposium, Portland, Oregon