

Installation, Operation, Maintenance, Inspection, and Repair of Tanks in Production Service

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Foreword

This standard is based on the accumulated knowledge and experience of Purchasers and Manufacturers of storage tanks of various sizes and capacities. This standard is meant to provide guidelines to install (set and connect), operate, maintain, inspect, and repair a tank in Production Service for the Petroleum Industry. This standard is not to be interpreted as approving, recommending, or endorsing any specific design or as limiting the method of design or construction.

It is not the intent to modify operating facilities; however, it is intended that any new work, operation, maintenance, inspection, and repair meet these requirements. The User may modify, delete, or amplify sections of this standard, but reference to this standard shall not be made on the nameplates of, or certification for, tanks that do not fulfill the minimum requirements of this standard. More stringent requirements specified by the Purchaser or furnished by the Contractor are acceptable as mutually agreed upon by the Purchaser and the Contractor. The Purchaser is responsible for specifying any jurisdictional requirements applicable to the design and construction of the tank.

Shall—denotes a minimum requirement to conform to the specification.

Should—denotes a recommendation which is advised but not required to conform to the specification.

This standard is not intended to cover storage tanks that are to be erected in areas subject to regulations more stringent than the specifications in this standard. If this standard is specified for such tanks, it should be followed insofar as it does not conflict with local requirements. Each edition, revision, or addendum to this standard becomes effective six months after the date of issuance for equipment that is certified as being constructed, tested, inspected maintained or repaired in accordance with this standard.

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Introduction

This standard is based on the accumulated knowledge and experience of Owner/Operators and Manufacturers of storage tanks of various sizes and capacities. This standard provides guidelines to install (set, connect), operate, maintain, inspect, and repair a tank in the upstream segment of the petroleum industry. This standard is not to be interpreted as approving, recommending, or endorsing any specific design or as limiting the method of design or construction.

It is not the intent to modify operating facilities; however, it is intended that any new work, operation, maintenance, inspection, and repair meet these requirements. The User may modify, delete, or amplify sections of this standard, but reference to this standard shall not be made on the nameplates of, or certification for, tanks that do not fulfill the minimum requirements of this standard. More stringent requirements specified by the Purchaser or furnished by the Contractor are acceptable as mutually agreed upon by the Purchaser and the Contractor.

This standard is not intended to cover storage tanks that are to be erected in areas subject to regulations more stringent than the specifications in this standard or for midstream or downstream segments of the petroleum industry. When this standard is specified for such tanks, it should be followed insofar as it does not conflict with local requirements. The Purchaser is responsible for specific jurisdictional requirements applicable to the design and construction of the tank. After revisions to this standard have been issued, they may be applied to tanks that are to be completed after the date of issue. The tank nameplate shall state the date of the edition of the standard and any revision and edition to which the tank has been designed and constructed. Each edition, revision, or addendum to this standard may be used beginning the date of issue on the cover page for that edition, revision, or addenda. Each edition, revision, or addenda to this standard becomes effective six months after the date of issuance for equipment that is certified as being constructed, tested, inspected maintained or repaired in accordance with this standard. During the six-month time between the date of issuance of the edition, revision or addenda and effective date, the Purchaser and the Manufacturer shall specify to which edition, revision, or addenda the equipment is to be constructed and inspected.

Installation, Operation, Maintenance, Inspection, and Repair of Tanks in Production Service

1 Scope

1.1 This standard provides the minimum requirements to install, operate, maintain, inspect, repair, and reconstruct both new and existing tanks used in petroleum production service in a manner that includes best practices for tank facility safety, security, and environmental protection.

1.2 Tanks in refineries, petrochemical plants, marketing bulk plants, and pipeline storage facilities operated by carriers are not within the scope of this standard.

1.3 This standard is intended primarily for application to tanks fabricated to API Specifications 12B, 12D, 12F, and 12P which are employed in onshore production services but may be applied to other tanks and services at the discretion of the Owner/Operator.

1.4 Annex G of this standard contains specific safety information applicable to tanks. For additional safety information, see other publications referenced within this standard.

1.5 The schematic drawings included in this standard are examples of some features described in the standard.

Lease automatic custody transfer (LACT) operations are covered in the *API Manual of Petroleum Measurement Standards*.

NOTE A bullet (•) at the beginning of a paragraph indicates that there is an expressed decision or action recommended or required to be addressed by or on behalf of the Owner/Operator. The Purchaser's responsibility is not limited to these decisions or actions alone. When such decisions and actions are taken, they are to be specified in documents such as requisitions, change orders, data sheets, and drawings.

2 Normative References

The following referenced documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Specification 12B, *Bolted Tanks for Storage of Production Liquids*

API Specification 12D, *Field Welded Tanks for Storage of Production Liquids*

API Specification 12F, *Shop Welded Tanks for Storage of Production Liquids*

API Specification 12P, *Fiberglass Reinforced Plastic Tanks*

API Recommended Practice 580, *Risk-Based Inspection*

API Standard 650, *Welded Steel Tanks for Oil Storage*

API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*

API Standard 2003, *Protection against Ignitions Arising Out of Static, Lightning and Stray Currents*

API Standard 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*

API Manual of Petroleum Measurement Standards, Chapter 2—Tank Calibration

API *Manual of Petroleum Measurement Standards*, Chapter 6—Lease Automatic Custody Transfer (LACT) Systems

API *Manual of Petroleum Measurement Standards*, Chapter 8—Manual Sampling of Petroleum and Petroleum Products

API *Manual of Petroleum Measurement Standards*, Chapter 19.4—Evaporative Loss Reference Information and Speciation Methodology

ASME Boiler and Pressure Vessel Code (BPVC) ¹ , *Welding, Brazing, and Fusing Qualifications*

NACE SP0178 ² , *Design, Fabrication, and Surface Finish Practices for Tank and Vessels to be Lined for Immersion Service*

NFPA 326 ³ , *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*

OSHA 26 CFR ⁴ , Part 1910, Occupational Safety and Health Standards, 1910 Subpart D, *Walking-Working Surfaces*

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purposes of this standard, the following terms and definitions apply.

3.1.1

alteration

Any work done on a tank that changes its physical dimensions or configuration.

3.1.2

applicable standard

The latest revision of the original 12 Series API specification.

3.1.3

API 12 Series

Tanks that comply with American Petroleum Institute Specifications 12B, 12D, 12F, or 12P.

3.1.4

change in location

Any relocation within or between well sites, fields, units, or plants.

3.1.5

change in service

A change from previous operating conditions such as specific gravity, corrosivity, or pressure.

3.1.6

condition examination (internal/external)

A review of history and physical observation of a tank and its peripheral equipment by a Qualified Condition Examiner.

¹ ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.

² NACE International, 15835 Park Ten Place, Houston, Texas, 77218-8340, www.nace.org.

³ National Fire Protection Association, 1 Battery Park, Quincy, Massachusetts 02169.

⁴ The Code of Federal Regulations is available from the U.S. Government Printing Office, Washington, DC 20402, www.gpo.gov.

3.1.7

corrosion rate

The total metal loss divided by the period of time over which the metal loss occurred.

3.1.8

corrosion rate life

The corrosion rate life of a tank is defined as follows:

$$\text{Corrosion Rate Life (years)} = \frac{(T_{\text{current}} - T_{\text{minimum}})}{\text{corrosion rate/year}}$$

where

T_{current} is the current minimum thickness measured at the time of inspection or the nominal plate thickness for the section of interest;

T_{minimum} is the minimum allowable thickness or the limiting section or zone at the end of the next operating period or when the next inspection is projected.

3.1.9

hot tap

A procedure for installing appurtenances penetrating the shell of a tank that is in service.

3.1.10

inspections

Detailed appraisals of the condition of a tank including sufficient measurements to estimate its remaining corrosion rate life. Inspections are categorized based on the portion of the tank being inspected and type of scheduling. (See Tables 1 and 2 in 6.1.3.4).

- a) External inspections—Inspections made without human entry or visual inspection of internal parts.
- b) Internal inspections—Inspections which require human entry or visual inspection of internal parts.
- c) Scheduled inspections—Routine inspections performed at intervals specified by the Owner/Operator based on the corrosion rate life of the class of tanks.
- d) Unscheduled inspections—Inspections prompted by results obtained from a Condition Examination or by an operational alert.

3.1.11

operational alert

Any operational malfunction of a tank which may signal a potential deterioration.

3.1.12

Owner/Operator

The legal entity responsible for operating a storage tank in the scope of this standard.

3.1.13

potential deterioration

Tank damage that is indicated by a warning sign of deterioration.

NOTE This warning may be obtained from corrosion coupons or fluid analysis and may indicate the need for a Condition Examination of a tank.

3.1.14**Purchaser**

The party which invokes the requirements of this standard as part of a purchase agreement on behalf of the Owner/Operator.

3.1.15**Qualified Condition Examiner**

A knowledgeable individual, designated by the Owner/Operator, who is capable of recognizing existing and predictable hazards. Required qualifications for a Qualified Condition Examiner are given in Annex A.2.

3.1.16**Qualified Inspector**

An individual with a working knowledge of the standard or specification which was originally used to provide the tank to be inspected and who possesses the capability to apply this document. Required qualifications for a Qualified Inspector are given in Annex A.1.

3.1.17**reconstruction**

The work necessary to cut down or disassemble a tank and subsequent reassembly at a new location.

3.1.18**Release Prevention Barrier (RPB)**

An RPB includes steel bottoms, synthetic materials, clay liners, concrete pads, and all other barriers or combinations of barriers placed in the bottom of or under a tank, which have the function of: a) preventing the escape of released material, and b) containing or channeling released material for leak detection. RPB design is covered in detail in Annex I of API Standard 650.

3.1.19**remote location**

The location for a tank which is sufficiently distant from any occupied buildings and public areas so that hazards associated with exposure to an external tank fire (e.g. thermal radiation, projectiles, pool fire due to inventory release, etc.) cannot reach them. Public areas include those facilities not owned/operated as part of the tank operations, but rather in use by the general public, such as roads deeded, dedicated, or otherwise permanently appropriated to the public for public use, occupied buildings, or other public infrastructure.

3.1.20**retaining ring**

A steel or concrete ring installed in the foundation to ensure berm stability.

3.1.21**routine operational examination**

A visual examination made by operators or technicians during their routine attendance at a facility to determine the occurrence of an equipment malfunction or a tank leak.

3.1.22**User**

Any party which makes use of this standard including, but not limited to, the Owner/Operator, Purchaser, Contractor and/or Consultant.

3.2 Acronyms and Abbreviations

LACT	lease automatic custody transfer
PPE	personal protective equipment
SPCC	spill prevention control and countermeasures
MFL	Magnetic Flux Leakage

VRU

Vapor Recovery Unit

4 Production Tank and Facility Design

4.1 Setting of New or Relocated Tanks

- **4.1.1** The location of tanks should be selected after considering operational needs, carrier requirements, prevailing winds, environmental, and safety conditions, and all local, state, and federal regulations governing such locations.
- **4.1.2** Tank spacing must comply with applicable local, state, and federal regulations. Requirements are to be included within the scope of work specified by the Owner/Operator. Tanks should be located in a straight line as shown in Annex F, Figure F.1. The minimum shell-to-shell spacing between tanks shall be 910 mm (3 ft) for personnel access, with spacing adjusted as needed to maintain clearance for piping or other obstruction (see 4.1.3).

4.1.3 If tanks are installed with pipeline connections facing one another, sufficient space shall be provided between tanks to allow safe inspection and operation of valves and other appurtenances. Personnel access to all piping connections for operations, inspection, and maintenance shall be considered in the design. Annex F, Figure F.2 shows examples of small, shop-welded tanks with foundation and connection configurations. Annex F, Figure F.3A, and Figure F.3B show examples of battery installations with piping configurations with diked firewalls used. The requirements for barriers, valves, drains, and vents shown in these figures are defined in more detail in the remainder of this standard.

4.2 Design for Spill Prevention and Containment

- **4.2.1** Aboveground storage tank facility spill prevention and containment must comply with applicable local, state, and federal regulations, and those requirements are to be included within the scope of work specified by the Owner/Operator.

4.2.2 A Release Prevention Barrier shall be used for new installations.

4.2.3 Dikes or firewalls shall be constructed as secondary containment to contain not less than the volume of the largest tank enclosed plus at least 10 percent additional tank volume or as required by local regulations (for emergency release containment). The secondary containment area shall be sufficiently impervious and be sloped so as to drain any water away from tanks and shall be kept cleared of any accumulations of combustible material, oil, basic sediment, and water.

4.2.4 At the option of the Owner/Operator, a pipe drain may be provided at the lowest point of the secondary containment area to permit draining accumulations of storm water. This pipe drain shall have a locked-closed valve outside the drainage area to ensure proper containment and control of fluids other than storm water. Retained storm water shall be inspected for any oil or produced water contamination prior to any disposal (drainage) process. Facility design provisions shall address control of other substances, such as saltwater, oil, and basic sediment to prevent being spilled within the diked area.

4.2.5 The foundation of a tank shall be designed and installed to:

- a) support the tank so that it shall remain vertical with a tolerance of plus or minus 2 degrees,
- b) elevate the tank to drain rainwater away from the base of the foundation and bottom of the tank.

4.2.6 The foundation subgrade shall be well-graded, compacted soil. The subgrade shall be raised at the center of the tank foundation to facilitate drainage toward the perimeter. Surface drainage shall be provided and sloped away from the tank.

NOTE See API Standard 650, Annex B for foundation considerations and API 650, Annex I for examples of subgrade protection.

4.2.7 The foundation subgrade shall be made of gravel, shell, sand, concrete, any combination of these or other durable materials which facilitate drainage and provides structural support. A retainer ring may be used to confine loose material and to facilitate detection of liquid drainage from below the tank.

4.2.8 The foundation shall be level at the circumference of the tank and larger than the tank diameter, unless a retainer ring is used. Level bases are required for tanks which are used for measurement of produced liquids.

4.2.9 If a retainer ring is used, small seep holes or tell-tale devices shall be provided as a means for visible leak detection and drainage.

- **4.2.10** For tanks with a need to calculate inventory/product levels for custody transfer, inventory, or safe operation and spill prevention, tank calibration shall be performed with the tank in place on the foundation pad after completion of hydrostatic testing. Calibration shall comply with *API Manual of Petroleum Measurement Standards*, Chapter 2.

4.3 Measurement, Sampling, and Transfer Connections

4.3.1 All tanks should be equipped to meet the following requirements for measurement, sampling, and operational efficiency.

4.3.1.1 All tanks shall be installed level. Inlet and outlet connections shall be located so as to cause level settlement of basic sediment during filling or draining.

4.3.1.2 The pipeline connection shall be located in the tank shell at a height so that the bottom of the pipe ell (firmly anchored) or other fitting on the inside of the tank is a minimum of 355 mm (14 in.) above the tank bottom. In cone-bottom tanks, the connection shall be 152 mm (6 in.) above the bottom to shell joint of the tank. A valve equipped with a tamper-proof sealing device shall be installed in this line immediately adjacent to the tank.

4.3.1.3 The fill line shall be located through the roof near the tank shell or penetrate the tank shell at the height of the pipeline outlet.

4.3.1.4 A downcomer inlet line may be required by some carriers. The downcomer inlet line shall extend down to below the nominal low-liquid level to reduce rolling or agitation of the stored liquids. The downcomer inlet line shall be vented for pressure/vacuum (siphon breaker) relief with at least two 12.7 mm ($1/2$ in.) holes directly below the roof.

4.3.1.5 For a flat-bottom tank, the drain line connection shall be minimum NPS 4 located either in the bottom adjacent to the tank shell or in the tank shell adjacent to the bottom. For cone-bottom tanks, it shall be in the center of a cone bottom.

4.3.1.6 The equalizer connection, if any, shall be located in the shell no closer than 305 mm (12 in.) from the top of the shell. This line shall have a valve equipped for sealing, which is accessible from the walkway.

4.3.1.7 Steam coils or hot water coils, if specified, shall be installed inside the tank in a manner which will not interfere with the taking of samples/measurements through the main thief/gauge or the auxiliary thief/gauge hatch.

4.3.1.8 The inlet and the outlet lines shall have valves installed at the first flange or threaded connection to the tank shell.

4.3.1.9 Sample valves, if used, shall be installed in accordance with *API Manual of Petroleum Measurement Standards*, Chapter 8. They shall be located a minimum of 1.8 m (6 ft) distance circumferentially from the pipeline outlet and the drain line connections and 2.4 m (8 ft) from the fill line connection. Sample cocks shall be equipped with non-leaking valves, plugged inspection tees, and tamper-proof sealing devices. Lines from all cocks should extend a minimum of 102 mm (4 in.) inside the tank.

4.3.1.10 A sample valve shall be installed 102 mm (4 in.) below the bottom of the pipeline connection.

4.3.2 Additional Tank Requirements

- **4.3.2.1** Except for tanks without the need to calculate inventory/product levels, all tanks used for measurement shall meet the following additional requirements:

4.3.2.2 The carrier's gauger shall be able to ensure that the carrier has complete control of the tank contents, while delivery is made to the pipeline.

4.3.2.3 The drain line shall be provided with a means for assuring inspection that its valve does not leak. The drain line shall be accessible at all times and be kept free from dirt, rock, or other obstructions.

4.3.2.4 All pipeline valves shall be provided with an independent means, such as a block-and-bleed system, to ensure that they seal properly.

4.4 Access

4.4.1 Normal aboveground operations of tanks shall be accessible from platforms and walkways. The tank roofs, platforms, walkways, and the area around the tanks shall be kept cleared of accumulation of oil, basic sediment, and surface water.

4.4.2 The main gauge hatch, valves, and other appurtenances requiring personnel access for operation or maintenance shall be made accessible from elevated platforms and walkways which provide clear walking/working surfaces so that personnel do not have to walk on the tank roof.

- **4.4.3** Elevated platforms, walkways, stairways, and handrails shall meet OSHA 29 CFR 1910, Subpart D (or equivalent national standard) requirements, or as specified by the Owner/Operator.

4.4.4 Piping, walkways, and platforms that rest on or against the tank shell or roof shall be secured to it.

4.4.5 The pipeline valve, drain valve, and test or inspection locations shall be accessible from a firm nonskid walking surface which is free of obstructions.

4.4.6 All piping and connections to openings in the roof, such as a filling line and vapor vent or breather line, shall be located to not interfere with opening and closing of hatch lids, or access to thief/gauge hatches.

4.5 Venting

4.5.1 The internal pressure shall be controlled to not exceed the design pressure of the tank.

NOTE See Annex G.3 for a list of some options available for control of combustible vapors.

- **4.5.2** All hatches, connections, and other access points shall be gasketed and kept closed during operation to minimize vapor emissions.

4.5.3 Venting design pressure limits are identified in the API 12 Series Specifications. Refer to the requirements of the referenced standard for tanks constructed to other standards.

4.5.4 When emergency venting is required, it shall be provided in accordance with API Standard 2000. All normal and emergency venting devices shall be maintained in good working order.

4.5.5 Vent connections shall be located on the tank roof.

- **4.5.6** Vent lines which can be blocked by valves shall have the valves carsealed or locked open during normal operations and shall only be closed for maintenance.

4.5.7 Pressure Vacuum (PV) vent valves shall be located at the highest point in the vent line, and the line shall not contain any liquid traps or blinds or valves unless locked or sealed open.

- **4.5.8** If hydrogen sulfide (H_2S) is present in the system, consideration shall be given to specification of using supported vent piping made from nonferrous materials, special alloys or internally coated steels to help prevent elemental sulfur or iron sulfide (FeS) deposition problems. If fiberglass-reinforced plastic is used, a 61 cm (2 ft) long section of steel pipe shall be installed on the open end. This steel pipe shall be electrically connected (bonded) to the tank shell.

4.6 Corrosion Protection

- **4.6.1** The Owner/Operator shall specify any additional requirement to protect the tank bottom from corrosion, which is of increased concern in low-resistance soils where soil side corrosion is anticipated. Methods of protection may include providing a vapor barrier, external coating, cathodic protection, and/or electrical isolation.
- **4.6.2** Protective coatings suitable for the environment at the location shall be applied to the exterior of the tank using acceptable surface preparation and application techniques.

NOTE Experience has shown that a major key to obtaining good coating protection lies in adequate surface preparation and third-party inspections.

- **4.6.3** For corrosive fluids or sour gas service, an internal lining, coating and cathodic protection system should be applied.

NOTE Use of sacrificial anodes without internal coating of the tank usually results in reduced anode life and is not recommended.

- **4.6.3.1** Owner/Operator specified coating (such as 100 % solids, epoxy, polyester, phenolic, or fiberglass-reinforced plastic) shall be applied with the surface preparation and application in accordance with both NACE SP0178 and Steel Structures Painting Council (SSPC) Standards. Prior to applying any coating material, the surface shall be inspected to ensure that it is clean and blasted to the proper standard.
- **4.6.3.2** The maximum design and operating temperatures shall be considered in coating selection for tanks.
- **4.6.3.3** If a tank contains both steam coils and an internal coating, the steam coils shall be located at least 304 mm (12 in.) from the coated surface to avoid coating damage.
- **4.6.3.4** Tank roofs should be internally coated when operating conditions in the tank are expected to create a corrosive environment in the vapor space.
- **4.6.3.5** Special construction techniques can be used for reducing tank corrosion in corrosive or sour service. Alternative roof types should meet applicable requirements of 12 Series Specifications or API Standard 650. One such technique is the placement of roof beams on the outside of the roof, which (in severely corrosive product environments) may reduce effect of internal corrosion on structural members, facilitates inspection and coating maintenance of roof framing.
- **4.6.3.6** A cathodic protection system that penetrates the water phase should be installed and maintained to prevent corrosion at the coating holidays.

NOTE 1 See API Recommended Practice 651 for procedures and practices for achieving corrosion control through the use of cathodic protection.

NOTE 2 Shortened anode life, due to elevated operating temperature, should be accounted for with initial design, and internal inspections should be scheduled accordingly.

4.7 Tank and Facility Safety and Security

- **4.7.1** With an Owner/Operator evaluation of risk at a facility, access barricades, or fencing and signs may be installed to protect the facility from unauthorized access and warn against hazards.

NOTE See Annex G for additional information.

4.7.2 As a minimum, the following signs shall be posted:

4.7.2.1 “Warning: NO TRESPASSING”, “Flammable Vapor”, “Combustible Gas”, “NO SMOKING” or similar signs shall be displayed at points in facilities where there is controlled access or boundary fencing. Where access is not controlled, warning signs shall be visible from normal road or pathway approach.

4.7.2.2 Tanks installed for production and storage of crude oil that contains toxic or poisonous gases, such as H_2S , should have signs posted at all entries to the facility and at the bottom entry of all stairways leading up to gauge hatches warning of the presence of toxic or poisonous substances.

4.7.3 All metallic tank components shall be electrically bonded to the metallic tank shell and grounded.

NOTE Equipotential bonding of tank components minimizes the chance of electrostatic discharge flashover events (see API Standard 2003).

- **4.7.4** Connection of the tank to a ground network should be provided.

NOTE Metallic tanks are considered grounded if placed directly on the ground and connected to grounded metallic piping (see API Standard 2003).

4.7.5 Non-steel storage tanks shall meet grounding and bonding requirements of API Standard 2003 and API Specification 12P. Grounding and flow velocity requirements of API Standard 2003 shall be followed for storage and transfer of hydrocarbons (crude oil and refined products, such as diesel, gasoline, and circulating oils, in small containers) at a production facility.

4.7.6 When retrofitting a tank, steel down-comer pipes should be considered to reduce the potential for static charge accumulations (see API Standard 2003).

- **4.7.7** The Owner/Operator shall evaluate facility lightning risk and specify requirements, if any.

NOTE Air terminals (“direct stroke devices”) in accordance with API Standard 2003, Annex C are not recommended for use on metallic tanks (considered grounded and protected by the “Faraday Cage Effect”), or for use in areas within the facility which are subject to combustible vapor exposure (such as near vents). Lightning strikes may cause tank fires/deflagrations; however, control of combustible vapor release is the primary consideration to avoid ignition. Lightning protection of non-metallic tanks is recommended (see API Specification 12P and API Standard 2003, Section on Non-Conductive Tanks).

5 Operations

5.1 Operating Safety

5.1.1 Operating pressure of the tank shall be controlled within the applicable design pressure limit (see 4.5.1).

NOTE It is important to control product vapor pressure to operate within design limits of the tank and related equipment. The boiling point is impacted by elevation and temperature. See *Manual of Petroleum Measurement Standards*, Chapter 19.4, including Addendum 1-2013 (where ASTM D6377 is referenced) for true vapor pressure determination.

- **5.1.2** Additional Owner/Operator considerations related to fire safety shall include, but not be limited to, control of authorized access, control of ignition sources (such as static, lightning and open flames), and the prevention of spills.

NOTE A primary consideration for fire safety is the control of combustible vapors (see 5.1.11 and Annex G.3).

- **5.1.3** At facilities where personal or fixed gas detection is used, the Owner/Operator shall establish procedures in accordance with OSHA regulations or equivalent national standards.
- **5.1.4** Tank entries shall be in accordance with API Standard 2015 or NFPA 326.

5.1.5 Except if specifically authorized by the Owner/Operator, operations which involve potential ignition sources (some examples: open fires, automotive and welding equipment, internal combustion engines, and open drip-proof electric motors) shall be prohibited inside dikes or firewalls and in any area within 15.2 m (50 ft) from sources of vapor release from un-diked tanks or oil accumulations.

- **5.1.6** The Owner/Operator of a tank shall establish a hot-work permit system prior to allowing any hot work to be performed on any tank. Hot work includes the following:
 - a) arc welding;
 - b) cad welding;
 - c) chipping;
 - d) flaming;
 - e) grinding;
 - f) painting around spark-producing equipment sources, such as open flames, internal combustion engines, welding equipment, and open drip-proof electric motors;
 - g) acetylene cutting;
 - h) abrasive blasting;
 - i) soldering;
 - j) torching; and
 - k) any other potentially spark-producing operations.

NOTE See API Recommended Practice 2009 for additional information on hot work and the permitting process.

- **5.1.7** The Owner/Operator shall develop safe liquid transfer procedures to prevent excessive pressure differential or static charge accumulation during filling/emptying operations.

NOTE Rapid transfer of liquid from an atmospheric storage tank presents the possibility of tank collapse. Rapid discharge can create a vacuum and development of negative pressure can occur even if a vent or thief/gauge hatch is installed, but not properly sized (see API Standard 2000) or maintained. Additionally, rapid transfer to a tank can result in excessive static charge buildup (see API Standard 2003).

- **5.1.8** Operations should establish procedures to avoid vent system blockage, including the possibility of material build up. Each such line shall remain unblocked to flow during operations including such methods as valves locked open, not using valves and not using blinds.

5.1.9 Personnel shall not be on or around tanks during thunderstorms.

- **5.1.10** When accessing tanks and equipment that have contained H_2S , personnel shall wear a gas monitor and other necessary PPE. There shall be a safety procedure to address evacuation in the event of high concentration of H_2S .

NOTE Opening of tanks and equipment that have contained H_2S can result in spontaneous combustion due to the presence of FeS (iron sulfide, a pyrophoric material) formation on exposed steel surfaces. Recognition of this potential ignition source is important in planning work in areas with potential for presence of combustible vapors.