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

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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 state and federal 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 deployed in onshore productions 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.

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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 653, Tank Inspection, Repair, Alteration and Reconstruction

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*

NFPA 30, Flammable and Combustible Liquids Code

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

OSHA 29 CFR 1910, Ergonomic Program

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.

BGRV
Blanket gas relief valve.

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.

3.1.7
corrosion rate
The total metal loss divided by the period of time over which the metal loss occurred.

[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.

3.1.8
corrosion rate life
The corrosion rate life of a tank is defined as follows:

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

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
existing above ground storage tank (AS) system
An in-place tank system being used to contain an accumulation of regulated substances, which was built to appropriate industry standards in accordance with a written installation plan specific to the system and the site that was prepared by a qualified tank professional, and where the owner or operator obtained all required federal, state, and local approvals or permits necessary to support the installation.

Flammable Liquid
Any liquid that has a closed cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in NFPA 30 Section 4.4, and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to NFPA 30 Section 4.3.

3.1.10
hot tap
A procedure for installing appurtenances penetrating the shell of a tank that is in service.

3.1.11
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—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.

3.1.12

new aboveground storage tank (AST) system

A proposed or in place AST system that has not been put in service and will be used to contain an accumulation of regulated substances. The AST system must be built to appropriate industry standards in accordance with a written installation plan prepared by a qualified tank professional and the plan is specific to the site, and where the owner or operator has obtained all federal, state, and local approvals or permits necessary to support the installation prior to tank system operation. Installation is considered to have commenced if the owner or operator has obtained all permits necessary to begin physical construction of the tank system site, or if a continuous on−site physical construction or installation program for the AST installation or AST system has begun.

3.1.13
Non-Skid Walking Surface
A walking surface that is designed to reduce the likely hood of accumulation of water, snow, and ice, with a surface designed to prevent slips, such as serrated bar grating.

3.1.14
operational alert
Any operational malfunction of a tank which may signal a potential deterioration.

3.1.15
Owner/Operator
The legal entity responsible for operating a storage tank in the scope of this standard.

3.1.16
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.*

3.1.17
Purchaser
The party which invokes the requirements of this standard as part of a purchase agreement on behalf of the Owner/Operator.

Pset
Pressure set point

PVRV
Pressure vacuum relief valve

3.1.18
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.

3.1.19
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.

3.1.20
reconstruction
The work necessary to cut down or disassemble a tank and subsequent reassembly at a new location.

3.1.21
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.

3.1.22
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.

3.1.23
retaining ring
A steel or concrete ring installed in the foundation to ensure berm stability.

3.1.24
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.

3.1.26
Storage Tank Engineer
One or more persons or organizations acceptable to the owner/operator who are knowledgeable and experienced in the engineering disciplines associated with evaluating mechanical and material characteristics that affect the integrity and reliability of aboveground storage tanks. The storage tank engineer, by consulting with appropriate specialists, should be regarded as a composite of all entities needed to properly assess the technical requirements.

Temporary Repair
Repairs made to a tank so as to restore sufficient integrity to continue safe operation of the tank until permanent repairs are conducted, per API 653

3.1.27
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

41.0 INSTALLATION

1.1. General

1.1.1. The location of tanks on a production facility should take into consideration:

a) Risk factors such as environmental site sensitivity, population density, etc.
b) Proximity to flares and other sources of ignition
c) Accessibility for truck loading
d) Prevailing winds
e) Flood prone areas
f) All local, state, and federal regulations governing such locations

1.1.2. Non-metallic tanks constructed to API 12P shall not be used to store flammable liquids.
Note: Caution should prevail when using a non-metallic tank to store produced water that may contain excessive hydrocarbons. A tank fire may result in a loss of all tanks.

1.1.3. Non-metallic tanks shall not be placed inside diked areas where steel tanks containing flammable liquids are located.

1.2. Setting of New or Relocated Tanks

1.2.1. Tank spacing must comply with NFPA 30 Chapter 22. Requirements are to be included within the scope of work specified by the Owner/Operator. Tanks should be placed to optimize vent header design and piping requirements. 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 Annex F).

1.2.2. 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. In no case shall the clear span walking space between any tank to tank clearance including projecting fittings, piping to valves be less than 30 in. 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.23A, and Figure F.23B 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.

1.2.3. Drainage shall be away from the tank bases. Surfaces around tanks should be graded to drain liquids away from tank bases, with low point for liquid accumulation as far away from the tanks as possible to limit exposure of tanks, piping and valves in case of liquids ignition.

1.3. Spill Containment

1.3.1. Aboveground storage tank facility spill prevention and containment requirements are to be included within the scope of work specified by the Owner/Operator.

1.3.2. A Release Prevention Barrier shall be used for new tank installations.

1.3.3. Dikes or containment walls 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 shall be kept cleared of any accumulations of combustible material, oil, basic sediment, and water.

1.3.4. At the option of the Owner/Operator, a sump may be provided at the lowest point of the secondary containment area to permit draining accumulations of storm water. Retained storm water shall be inspected for any oil or produced water contamination prior to any disposal outside of containment. Automated level control sump pumps shall not be used as the storm water must be checked for an

oil sheen or contamination prior to discharging the water. Facility design provisions shall address control of other substances, such as saltwater, oil, and basic sediment to prevent them from being spilled within the diked area.

1.3.5. During the design phase, an ~~An~~ evaluation of spill prevention, containment, and countermeasure requirements shall be made on a site- specific basis. Documentation shall follow all State and Federal requirements. These requirements shall be followed during construction.
NOTE: *In addition to regulatory requirements, see API Bulletin D-16 for spill prevention measures which may be used*

1.3.6. Wastewater and other substances, (such as saltwater, oil, and basic sediment spilled within the diked area) shall be properly controlled and disposed. API Publication E5, as well as applicable regulations, may be consulted for remediation and disposal of these substances.

1.3.7. The Owner/Operator should establish operating practices or install tank level detection with alarms to ensure operator is aware and managing levels for tank inside the secondary containment.

1.4. Foundations for Steel and Non-Metallic Tanks

1.4.1. 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) Provide strength and stability to support the tank to resist excessive settlement.
- c) Elevate the tank above surrounding grade to provide drainage away from the base of the foundation and bottom of the tank so that spilled liquid can be drained to a low point within secondary containment away from the tanks.
- d) Provide a level base to support the tank walls and bottom.
- e) Comply with any recommendations of a geotechnical investigation.

1.4.2. The foundation design is governed by soil characteristics at the tank site and may consist of the following types:
- a) Compacted granular berm with or without retainer ring.
- b) Reinforced concrete ring wall with compacted backfill.
- c) Reinforced concrete slab or mat.
- d) Composite base designed for the weight of the tank.
- e) Steel beams with or without steel pilings of suitable size.

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

1.4.3. The foundation shall be level at the circumference of the tank base with no portion of the tank floor extending past the foundation (no overhang).

1.4.4. Consideration of foundation subgrade material should also take into account tank bottom corrosion from materials that may be high in levels of chlorides or other corrosive components. The use of protective coatings or moisture barriers should be considered where soil/environmental conditions have increased potential to create a corrosive environment.

1.4.5. If a retainer ring is used, 1” (or greater) seep holes or tell-tale devices shall be provided as a means for visible leak detection and drainage. These drain/leak-detection openings shall be spaced around the retainer ring circumference at intervals determined by the Owner.

1.4.6. The tank foundation subgrade shall be well-graded, compacted soil. For field erected tanks placed directly on compacted soil, the subgrade where the tank is placed shall be raised to facilitate drainage toward the containment perimeter.
NOTE: *See API Standard 650, Annex B for foundation considerations and API 650, Annex I for examples of subgrade protection*

1.4.7. Foundations for non-metallic tanks shall fully support the tank floor across the full diameter of the floor. Concrete slabs, compacted soil, polymer pads or ringwalls (for skirt supported tanks) are acceptable options. Refer to API 650, Annex B, Section B.4.4 – Slab Foundations or API 650, Annex B, Section B.4.2 – Earth Foundations with a Concrete Ringwall.

1.4.8. Foundations for skirt supported metallic tanks shall be suitable for the loads exerted along the skirt ring. Typical foundations would be a concrete ringwall, or transportable tank base.

1.5. Safety and Security

1.5.1. 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*

1.5.2. The Owner/Operator should consider posting the following signs as required by local, state or federal requirements. Examples are as follows:
a) "Warning: No Trespassing",
b) "Warning: Flammable Vapor",
c) "Warning: Combustible Gas",
d) "Warning Poison Gas"
e) "Warning: No Smoking"
f) "Warning: Vapors under Pressure" or,
g) 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.

1.5.3. Tanks installed for production and storage of crude oil that contains toxic gases, such as H_2S, - shall 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.

1.5.4. 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 in the tank vapor space. (see Annex G.3)*

1.5.5. 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 for the use, preventative maintenance and calibration of such equipment.

1.6. Electrical

1.6.1. All metallic tank components shall be electrically bonded to the metallic tank shell.

1.6.2. Non-metallic storage tanks shall meet grounding and bonding requirements of API Standard 2003 and API Specification 12P.

1.6.3. The tank shall be connected to an earthen ground.
NOTE: *Equipotential bonding of tank components minimizes the chance of electrostatic discharge flashover events. (see API Standard 2003)*

1.6.4. When a ground network is provided at the facility, tanks should be connected to that network.
NOTE: *Metallic tanks are considered grounded if placed directly on the ground and connected to grounded metallic piping (see API Standard 2003)*

1.7. Venting

1.7.1. The internal pressure of the tank 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.*

1.7.2. 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.

1.7.3. When emergency venting is required, it shall be provided in accordance with API Standard 2000.
NOTE: *When an ERV is required it is vital, to reduce premature wear and subsequent leakage from the ERV, to optimize the Pset of the ERV and PVRV whilst maximizing the operational pressure range of the tank.*

1.7.4. The operating pressure of the tank shall be controlled within the applicable design pressure established for normal and emergency venting scenarios. In order to minimize venting, normal operating pressure should be controlled to be 90% or less than the normal vent opening set point. Lower operating pressure allows pressure relief vents to maintain tighter seals.
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.*

NOTE: *Most vent manufacturers test their vents for leakage in accordance with API2000. The vents will be leak rate tested at 75% of set pressure, operators should seek advice from each manufacturer prior to selecting an operating pressure of the tank above 75% Pset. API2000 offers no restriction on how much a valve is permitted to leak above 75% of its Pset. There are certain vent manufacturers who, as standard procedure, commit to exceeding the leakage rate requirements set within API2000 at 90% of Pset.*
Production leakage test reports should be supplied to the operator with every vent purchased. Additionally, documented evidence from repeat cycle testing should be made available to ensure that an operator can select a durable solution to control tank venting.
If blanketing gas is to be used on the tank, the operator should request blowdown or reseating pressure of the PVRV. This is critical to avoid the scenario where the BGRV opens before the PVRV has closed which would result in purging blanketing gas to atmosphere
Where there are both Normal and Emergency venting devices, the separation of set-points between the devices shall be sufficiently large so that the ~~blowdown~~ leakage pressure of the emergency vent device is above the maximum accumulation pressure of the normal venting device.

1.7.5. Tank venting devices shall be sized to accommodate maximum liquid transfer rates, or the Owner/Operator shall develop safe liquid transfer procedures to prevent excessive pressure or vacuum accumulation in a tank. The Owner/Operator shall consider flows from a failed upstream valve, often referred to as “blowby”.
NOTE: *Rapid transfer of liquid from an atmospheric storage tank presents the possibility of tank collapse due to vacuum formation inside the tank. High fluid transfer rate into a tank can create high internal pressure with high developed stress at shell/floor and shell/roof joints that can result in tank failure or rupture. Excessive pressure or vacuum conditions can occur even if a pressure or vacuum relief device is present on the tank if it is not properly sized (see API Standard 2000) or maintained.*

1.7.6. 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. Block valves, if installed at pressure/vacuum device inlet or outlet shall be secured open by lock or seal.
NOTE: *PVRV flow curves are generated in accordance to API2000. If valves are installed outside of the parameters which determine the flow curve, then valve capacities can no longer be guaranteed. For example, for PVRVs installed on vent headers or extended tank nozzles, inlet loss and back pressure calculations should be considered and device performance should be confirmed with the vent manufacturer.*
During the life of a tank battery vent piping and headers may need alteration. Vent capacities should be reconfirmed with the vent manufacturer.

1.7.7. Block valves installed in vent lines should be secured open with locks or seals, or located so the valves are not readily accessible. These valves shall only be closed for maintenance of the associated tank(s).

1.7.8. Any service condition changes that affect tank design pressure, venting product set points, piping layout, etc. can affect the venting capacity of venting products installed on the tank. The Owner shall review tank venting capacity requirements if service conditions change to ensure that existing venting products can meet the required venting capacity for the new service.

1.8. **Tank Access**

1.8.1. All routinely operated equipment such as valves, gauges, and sampling stations shall be accessible from platforms and walkways. The tank platforms, walkways, and the area around the tanks shall be kept cleared of accumulation of oil, basic sediment, and surface water.

1.8.2. 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.

1.8.3. 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.
NOTE: *See Annex E.*

1.8.4. Piping, walkways, and platforms adjacent to the tank shell or roof shall be secured to the tank.

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

1.9. **Corrosion Protection**

1.9.1. The Owner/Operator shall specify any additional requirement to protect the tank bottom from corrosion, which is of increased concern in low-resistance and high salinity soils where soil side corrosion is anticipated. Methods of protection may include providing a foundation elevation that is elevated above the surrounding grade, vapor barrier, external coating, cathodic protection, and/or electrical isolation

a) Elevating the foundation assists to reduce corrosion due to the possibility of flooding and water intrusion into the foundation.

b) Concrete slab foundations help to reduce corrosion resulting from the inherent alkalinity of concrete.

1.9.2. 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.
Coating the bottom side of the tank floor is recommended where soil side corrosion is a concern.
NOTE: *Experience has shown that a major key to obtaining good coating protection lies in adequate surface preparation and independent third-party inspections*

1.9.3. 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.*

1.9.4. All internal surfaces, including the floor, shell and roof, should be internally coated when operating conditions in the tank are expected to create a corrosive environment in the vapor space.

1.9.5. A cathodic protection system that penetrates the water phase should be installed and maintained to prevent corrosion at any coating holidays that may be present.
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.*

1.9.6. The maximum design and operating temperatures as well as “immersion service” shall be considered in coating selection for tanks. Tank roof coatings should be designed for full exposure to sunlight and immersion service if water can pool on the roof at any location.

2. OPERATION

2.1. General

2.1.1. Personnel should not be on or in close proximity to tanks during thunderstorms where lightning is within 10 miles of the tank. The Owner/Operator shall evaluate facility lightning risk and specify requirements, if any. No operators shall be on a tank performing any maintenance on a tank during lightning events.

NOTE: ~~———~~ *Air terminals ("direct stroke devices") in accordance with API 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)*

~~2.1.1.~~

NOTE: *Follow public alert guidance provided by the National Weather Service for severe weather watches, warnings, and advisories.*

2.1.2. All tanks and equipment at oil/gas production sites, including produced water storage, treating, and disposal, should be assumed to contain hydrocarbons and combustible gases and therefore contain flammable vapors. Access to and around the tank requires monitoring for safe atmosphere combustible vapors, and necessary PPE. There shall be a safety procedure for access to the tank.

2.1.3. All hatches, connections, and other internal access points shall be gasketed and kept closed during operation to minimize vapor emissions. NOTE: *The Owner should work toward eliminating vapor emissions through careful engineering design of the vent system.*

2.1.4. When accessing tanks and equipment that contain or may contain H2S, personnel shall wear a gas monitor calibrated for H2S detection, and other necessary PPE. Supplied breathing air may be required if required tasks require opening hatches or valves where H2S is present. There shall be a safety procedure to address evacuation or rescue in the event personnel are exposed to high concentration of H2S.

NOTE: *Opening of tanks and equipment that have contained H2S 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. Opening tank hatches or connections may expose personnel to elevated H2S concentrations, which can cause life threating symptoms such as loss of consciousness, breathing distress or cardiac arrest.*

2.1.5. Entry into tanks by personnel shall be in accordance with API Standard 2015 or NFPA 326, and OSHA 29 CFR 1910.146.

2.1.6. The Owner/Operator of a tank shall establish a hot-work permit system prior to authorizing any hot work to be performed on a tank. Hot work includes, but is not limited to the following:

a) Welding operations;
b) Chipping;
c) Flame/torch heating;
d) Grinding;
e) Painting around spark-producing equipment sources, such as open flames, internal combustion engines, welding equipment, and open drip-proof electric motors;
f) Acetylene cutting,
g) Abrasive blasting;
h) Soldering,
i) Electrically powered lighting or instruments,
j) Any other potentially spark-producing operations

NOTE: *See API Recommended Practice 2009 and NFPA 51B for additional information on hot work and the permitting process*

2.1.7. Except if specifically authorized by the Owner/Operator, operations which involve potential ignition sources shall be prohibited inside dikes or firewalls where vapors may accumulate and in any area within 15.2 m (50 ft) from sources of flammable vapor release from un-diked tanks or flammable/combustible fluid accumulations. Whenever any hot-work is done within diked areas, the company approved hot-work permit process shall be required and applied.

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NOTE: *Ignition source examples include open fires, automotive and welding equipment, internal combustion engines, and open drip- proof electric motors.*

~~2.1.8.~~1.1.1. ~~The Owner/Operator shall evaluate facility lightning risk and specify requirements, if any. No operators shall be on a tank performing any maintenance on a tank during lightning events.~~

~~NOTE: Air terminals ("direct stroke devices") in accordance with API 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)~~

~~2.1.9.~~2.1.8. Operations shall establish operating procedures to manage liquid transfers in and out of tanks to reduce potential for static discharge inside the tank.

a) Velocities of liquids in lines entering tanks shall be limited to 20 ft./s
b) Two phase flow should be minimized
c) Tanks shall not be hand gauged until at least 30 minutes after the tank has been isolated.

NOTE: *Rapid fluid transfer to or from a tank can result in excessive static charge buildup if electrical bonding/grounding is not adequate (see API Standard 2003)*

2.2. MEASUREMENT

2.2.1. Where a flammable atmosphere can be expected in the vapor space of a tank, metallic or conductive objects such as gauge tapes, sample containers, and thermometers should not be lowered into or suspended in the compartment, either during or immediately after loading of product. Depending on the compartment size and the conductivity of the product being loaded, a sufficient waiting period should be followed to permit the product charge to dissipate. A 30 minute waiting period is recommended.

2.2.2. Tanks should be equipped to meet the following requirements for measurement, sampling, and operation:

a) Inlet and outlet connections shall be located so as to cause level settlement of basic sediment during filling or draining.
b) 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. A sample valve shall be installed 102 mm (4 in.) below the bottom of the pipeline connection.

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

a) 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.
b) The drain line shall be provided with a means for assuring inspection that its valve does not leak.
c) The drain line shall be accessible at all times and be kept free from dirt, rock, or other obstructions.
d) All pipeline valves shall be provided with an independent means, such as a block-and-bleed system, to ensure that they seal properly

2.2.4. 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.

3. MAINTENANCE

3.1. General

3.1.1. The Owner/Operators of tanks shall have a preventive maintenance program to help ensure tank integrity for normal service without undue expectation of endangering workers, the public, or the environment.

3.1.2. The preventive maintenance program may include draining of bottom water or sediment, or both, removal or draining of secondary containment water (should be tested for contaminants prior to draining), replacement of gaskets, replacement of vent seals, inspection of sacrificial anodes, and repair of coatings and linings.

~~3.1.2.~~3.1.3. Consider manufacturers recommendations for maintenance of appurtenances.

4. INSPECTION

4.1. General

4.1.1. The methods of this section are intended to ensure storage facilities in the upstream segment of the petroleum industry maintain functional integrity and fitness for service. These practices are accepted methods of examination, inspection, and maintenance. However, other methods which combine some or all of these practices in combination with risk-based assessment and management practices can be more effective on the whole. Therefore, nothing in this section is intended to preclude the use of other methods of examination, inspection and maintenance that when combined with statistical based processes or with risk assessment and management will yield equivalent or better results.

4.1.2. All steel tanks fabricated to Specification 12B or Specification 12D, and greater than 9.17 m (30 ft) in diameter should be inspected and repaired in accordance with procedures of API Standard 653.

4.1.3. Routine In-Service Inspections ~~visual inspections~~ are important to ensure a long-term leak free condition. The inspection is performed on a regular basis, often monthly, to identify any issues that may arise with a tank such as mechanical damage, corrosion damage, leaks and other integrity issues that may require further inspection by a Qualified Inspector.

~~4.1.4.~~ Routine In Service Inspections ~~visual inspections~~ should include:

a) Identification of any visible or indications of leaks at flanges, weld joints, shell or bottom plate;
b) Indications of overfill or over pressure;
c) Indications of mechanical damage such as dents and bulges;
d) Areas of significant corrosion;
e) Visible or indications of settlement;
f) Damage to secondary containment;
g) Damage to foundation;
h) Missing identification or hazard signs and stickers

NOTE: *Routine In-Service Inspections may be done by owner/user personnel or by others. Personnel performing this inspection should be knowledgeable of facility operations, the tank, and the characteristics of the product being stored.*

~~4.1.5.~~4.1.4. When visual inspections identify an integrity concern, or as required by or in accordance with the Owner / Operator's Tank Integrity program, a Thorough inspection by a Qualified Inspector shall be performed.

~~4.1.6.~~4.1.5. For a change in service, the following must be evaluated:

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a) The Tanks current Integrity.
~~a)~~b) Stress levels and allowable stress levels;
~~b)~~c) Properties of the stored product such as specific gravity, vapor pressure, temperature, chemical composition and corrosivity;
~~c)~~d) Metal design temperatures at the service location of the tank (see note);
~~d)~~e) External roof live, wind, snow,
~~e)~~f) Chemical analysis and mechanical properties of the construction materials;
~~f)~~g) Tank design pressure, venting product set points, piping layout, etc. that can affect the venting capacity of venting products installed on the tank. Review tank venting capacity requirements if service conditions change to ensure that existing venting products can meet the required venting capacity.

~~4.1.7.~~4.1.6. ~~The~~ A Thorough inspection shall determine the suitability of an existing tank for continued service, for a change of service, or making decisions involving repairs, alterations, dismantling, relocating, or reconstructing an existing tank, the following ~~must~~ shall be evaluated:

a) Internal corrosion due to the product stored or water corroding the bottom, roof and/or shell;
b) External corrosion due to environmental exposure;
c) Tank foundation, soil, and settlement conditions;
d) Distortions of the existing tank;
e) Operating conditions, such as filling or emptying rates and frequency;
f) Condition of existing coating, lining, or cathodic protection system;
g) Combinations of any of these factors together with pressure due to the fluid settlement; and
h) Any other factor or condition specified by the Owner/Operator.

NOTE: *For welded steel tanks, a procedure for assessment of brittle fracture is included in API Standard 653, Section 5. If the operating temperature is expected to be less than 0 deg F, than a brittle fracture evaluation should be performed.*

NOTE: *Refer to Annex D Minimum Thickness for Tank Elements, for guidance in determining extent of repairs.*

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4.2. Inspection Protocols

4.2.1. Jurisdictional regulations, in some cases, control the frequency and interval of the inspections. These regulations may include vapor loss requirements, seal condition, leakage, proper diking, and repair procedures. Knowledge of such regulations is necessary to ensure compliance with the scheduling and inspection requirements.

4.2.2. Inspections are important to ensure a long-term leak free condition. Inspections are conducted internally and externally and ~~should~~ shall be performed by ~~highly skilled knowledgeable and trained personnel called the~~ a Qualified Inspector.

4.2.3. ~~For tanks that have internal linings or proven nil corrosion rate plus a secondary containment, only monthly, routine in-service inspections are required~~.

4.2.4. If ownership or the service of a tank changes, the new Owner/Operator should obtain the original records and files of the tank. If adequate records are not available, the new Owner/Operator should consider performing an Internal Inspection by a Qualified Inspector

4.2.5. This standard includes three fundamental approaches to inspection of upstream tanks. They are called:

4.2.5.1 Inspection Protocol 1: This method is based on time intervals and experience that establish a maximum period between the various inspections (visual, formal external and formal internal). This methodology is similar to the methods of API 653 for inspection of downstream tanks.

4.2.5.2 Inspection Protocol 2: This method is called *Adaptive Bayesian Tank Inspection* Protocol or Adaptive Inspection.

- Inspection Protocol 2 only determines the tank interval based on bottom life for steel flat bottom tanks and what fraction of tanks will be inspected. Other types of tanks shall be inspected to Inspection Protocol 1 or to a protocol specifically developed for that tank type. Therefore, if some other component of the tank bottom requires an inspection, then the other criteria shall govern, and shall address when the tank is taken out of service. Protocol 2 starts with data accumulated by NIST from a study of buried piping. As new data is collected the Protocol 2 is updated to provide better parameter estimates for the corrosion rate distributions and survival distributions. The method allows for a percentage of tank population such as 50% or 75% to be inspected on a regular basis throughout the time horizon. The failure rate of steel tank bottoms is based on survival functions which account for the corrosion rate distributions and the percentage of tanks being inspected. The protocol takes into account relative costs for tank installation, spills, and out of service inspections. The optimal time of inspection in years is based on optimizing the costs (which do include environmental costs of spills). The model improves as more data is fed into the program on an annual or other basis.
- Other than those tanks within the Protocol 2 Program the inspection intervals should be determined by its service history unless special reasons indicate that an earlier inspection must be made. A history of the service of a given tank or a tank in similar service (preferably at the same site) should be available so that complete inspections can be scheduled with a frequency commensurate with the corrosion rate of the tank but not greater than ¾ of the remaining life or 20 years, whichever is greater. On-stream, nondestructive examination methods shall be considered when establishing inspection frequencies.

4.2.5.3 Inspection Protocol 3 (Tanks Not within Inspection Protocol 1 or 2)
Periodic in-service inspection of tanks shall be performed as defined herein. The purpose of this inspection is to assure continued tank integrity. Inspections, other than those defined in API 653 shall be directed by a Qualified Inspector.

4.2.6 Several factors must be considered to determine inspection intervals for storage tanks. These include, but are not limited to, the following:

a) The nature of the product stored;
b) Internal coatings and lining;
c) Secondary containment design such as double bottom or release prevention barrier;
d) The location of tanks, such as those in high risk areas;
e) The potential risk of air or water pollution;
f) Corrosion allowances and corrosion rates;
g) Conditions at previous inspections;
h) The methods and materials of construction and repair;
i) Jurisdictional requirements;
j) Changes in service;
k) Standard to which the tank was built (i.e., API 12B, 12D, etc.)

4.3. **External Inspections –**
This section covers all external inspections

4.3.1. All applicable tanks shall be given a visual external inspection by an ~~authorized~~ qualified inspector. This inspection shall be called the external inspection and must be conducted at least every 5 years or when operational examinations warrant further inspections as a result of the identification of an operational alert, malfunction or a suspected shell, roof or bottom leak.

4.3.2. External inspections should include a visual inspection of the tank exterior surface to check for leaks, shell distortion, and evidence of corrosion and to determine the condition of the foundation pad, drainage, coatings, cathodic protection (if any), appurtenances, and connections. The need for

additional detailed inspections such as level surveys, magnetic particle examination and thorough UT surveys can be determined during the external inspection.

4.3.3. Insulated tanks may need to have the insulation removed only to the extent necessary to determine the condition of the exterior wall of the tank or roof if there is corrosion suspected under insulation corrosion.

4.3.4. For elevated tanks, visual inspection of the bottom side to inspect for leaks, cracks, bottom side corrosion or other defects should be done.

4.3.5. Tank bonding and grounding system components such as shunts or mechanical connections of cable shall be visually checked. Recommended practices dealing with prevention of hydrocarbon ignition are covered by API 2003.

4.3.6. External, ultrasonic thickness measurements of the shell can be a means of determining a rate of uniform general corrosion while the tank is in service and can provide an indication of the integrity of the shell or roof as well as the floor if it is accessible. The extent of such measurements shall be determined by the owner/operator.

4.3.7. When used, the ultrasonic thickness measurement shall be made at intervals not to exceed the following:

a) When the corrosion rate is not known, the maximum interval shall be five years. Corrosion rates may be estimated from tanks in similar service based on thickness measurements taken at an interval not exceeding five years.
b) When the corrosion rate is known, the maximum interval shall be smaller of RCA/2N years (where RCA is the difference between the measured shell thickness and the minimum required thickness in mils, and N is the shell corrosion rate in mils per year) or 15 years.

4.3.8. Where exterior tank bottom corrosion is controlled by cathodic protection system, periodic surveys of the system shall be conducted in accordance with API 651. The owner/operator shall review the survey results.

4.3.9. The owner/operator shall assure competency of personnel performing surveys.

4.3.10. Settlement of tanks under 50-foot diameter only require plumb measurements in two directions. (Tanks over 52 feet in diameter will require a full settlement survey as per API 653 Appendix B.)

4.3.11. Tank vents, installed on directly on to tank nozzles or on to vent header systems shall have pressure and vacuum set points verified by the Owner/Operator utilizing a low pressure valve test bench. During this test, seat leakage will be checked and shall not exceed values stated within API2000. Valves with excessive seat leakage shall be refurbished to reduce seat leakage to within or greater than the limits stated within API2000. Replace valve if necessary.

~~4.3.11.~~4.3.12. Annex B provides an example of a check list for an external inspection.

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Table 1 - External Tank Examination/Inspection Schedule

Scheduled Type	Frequency	By Whom
Routine ~~Operational~~ In Service Inspection (see	At least once a month.	Operations Personnel

External Inspection (see 4.3.4)	Once every five years	Qualified Inspector
Unscheduled Type	**Frequency**	**By Whom**
External Inspection (see 4.3.4)	If operational alert, malfunction, shell or roof leak, or potential bottom leak is reported as a result of ~~an operational examination~~a Routine In-Service Inspection.	Qualified Inspector

4.4. **Internal Inspections –**

4.4.1. Applicable tanks shall be given a visual internal inspection by a Qualified inspector. This inspection shall be called the Thorough inspection and must be conducted as per Section 4.2, Protocol 1, 2 or 3 or when routine or external visual examinations warrant further inspections.

4.4.2. A Thorough inspection must be completed when the tank undergoes a change in service more than 5 years after the last Thorough inspection or the tank is transferred to a new location.

4.4.3. Internal inspections should:

a) Ensure the bottom is not severely corroded and leaking;
b) Gather the data necessary for the minimum bottom and shell thickness assessment;
c) Identify and evaluate any tank bottom settlement;
d) Establish and evaluate corrosion rates for the bottom, shell and roof.
e) Ensure that the tank bottom and internal pipping are not severely corroded and leaking.
f) Gathering the data necessary for the minimum bottom and shell thickness assessments. As applicable, this data should also consider the internal and external ultrasonic thickness measurements made during in-service inspection.
g) Identify and evaluate any tank bottom settlement for tanks that are used for fluid measurement.
h) Evaluate tanks for stresses associated with bottom settlement.
i) Evaluate rate of corrosion of the roof and the corrosion rate associable with the tank structural supports such refers and center poles.
j) Evaluate the degree of corrosion protection provided by cathodic protection and/or internal coatings.
k) Visually examine and evaluate the condition of the shell welds to determine suitability for continued service, need for other nondestructive, or need for repair.

~~k)~~ 4.4.4. Annex C provides an example of a check list for an external inspection.

Table 2 - Internal Tank Examination/Inspection Schedule

Scheduled	Frequency	By Whom
Thorough Inspection (see 4.1.7 ~~and 4.1.8~~)	Except as allowed in 4.1.2, if a tank is: a) Cleaned for normal operations more than five years after the last Internal condition examination or inspection. b) Transferred to a new location. c) Service of a tank is changed more than five years after an inspection. d) Entered for any type of maintenance or modification.	Qualified Inspector

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Thorough Inspection (4.1.4)	At the end of ¾ of remaining life ~~(see 4.2.3)~~, but not more than an interval of 20 years.	Qualified Inspector
Thorough Inspection (see 4.1.4)	If warranted by the results of a Routine Operational Inspection.	Qualified Inspector

4.5. Evaluation

4.5.1. The following evaluations may be performed by the Qualified Inspector
- a) Corrosion rate and remaining life of floor, shell, roof or static internal appurtenances such as pipe
- b) Repairs based on corrosion rate and remaining life

4.5.2. The following evaluations shall be performed by a Storage Tank Engineer:
- a) Settlement survey analysis
- b) Stress analysis
- c) Evaluation of dents, distortions or other mechanical damage
- d) Corrosion rate and remaining life of mechanical appurtenances and supports
- e) Repairs based on the above evaluations

5. REPAIR

5.1. General

5.1.1. Repairs shall be made if the condition examination or inspection or Annex D indicate they are required. Tanks over 9.17m (30 ft) in dimeter shall be repaired in accordance with API Standard 653.

5.2. Types of Repairs

5.2.1. Temporary patches to tanks shall meet the following requirements
- a) Fiberglass-reinforced plastic or epoxy patches may be used as a temporary repair of minor damage to non- metallic tanks
- b) Non-metallic repairs to steel tanks are prohibited unless an engineering evaluation shows that the repair will be suitable for the remaining service life of the tank.
- c) Bolted patches, steel or plastic plugs of permanent connection type may be applied based on an engineering evaluation that considers the stresses, stress concentrations, and fatigue. Large areas of damage over 150 mm (6 in.) in diameter to steel tanks shall not be repaired with soft patches without conducting an engineering evaluation to determine if it is acceptable for continued service.

5.2.2. Selection of a particular repair method shall be evaluated by the Owner/Operator for suitability for service for the intended operational period.

5.2.3. Temporary repairs shall be documented and put into a records management system that ensure that they will be repaired in an appropriate time for conversion to permanent repairs.

5.3. Replacement Shell Plate

5.3.1. The thickness and material of the replacement shell plates shall meet the requirements of the standard used for the original construction.

5.4. Weld Joints

5.4.1. The following Welding and Inspection Requirements shall apply:

a) Welding on specialty coated, lined, or API Specification 12B (bolted) tanks is not permitted.

b) Welding consumables shall conform to the American Welding Society (AWS) Classification applicable to the intended use.

c) New weld joint detail shall meet the welding requirements of the current revision of the applicable standard.

d) All welding and inspection shall be done using approved welding procedures, by qualified welders and qualified inspectors in accordance with ASME IX and ASME V.

5.5. Weld Repair

5.5.1. The following requirements apply to weld repairs:

a) All butt-welded repairs shall be full fusion and full penetration on the shell, the roof, and the bottom,

b) Cavities resulting from gouging or grinding operations to remove weld defects shall be examined by visual and magnetic particle or liquid penetration methods.

c) A lap-welded patch plate may be used to repair an individual pit or pin-hole leak, subject to Owner/ Operator approval, provided that it meets the following conditions:

1) It is designed as a reinforcing plate,

2) fillet welds joining lap plates to existing plate(s) shall be inspected over their full length by visual, or magnetic particle, or liquid penetrant methods

5.6. Shell Penetration Repair

5.6.1. Repairs to existing shell penetrations shall be in compliance with the applicable standard.

5.6.2. Reinforcing plates shall be added internally or externally for the repair of unreinforced or leaking nozzles.

5.6.3. Welding performed on plate that has been exposed to or will be exposed to H2S shall be evaluated by the Owner/Operator to determine if special welding procedures are required.

5.7. Hot Taps

5.7.1. Hot taps should be avoided, but when they are to be used, then they shall be made in accordance with API Standard 653, Section 9.14.
NOTE:*Also see API Recommended Practice 2201, which further supplements information for safely conducting hot tapping*
5.7.2. Heat transfer analysis methods shall be applied to ensure that burn through will not occur.

5.8. Leak Detection with Bottom Replacement

When planning a tank bottom replacement, consideration shall be given to applying a leak prevention barrier.

NOTE *See API 650, Annex I on "Release Prevention Barrier" for various examples of construction details used for under-tank leak detection and subgrade protection*

5.9. Reconstruction of a Dismantled Tank

5.9.1. Prior to reconstruction of a dismantled tank, all internal and external parts shall be inspected, and parts found defective shall be replaced.
5.9.2. Any reconstructed tank shall be in accordance with the latest version of the applicable standard.
5.9.3. After repairs, alterations, and/or reconstruction is completed, any internal or external coating shall be repaired if required for corrosion prevention in the current service.
5.9.4. If reconstructing a bolted tank, all parts shall be cleaned and inspected for corrosion/damage. Coating damage shall be repaired. New hardware and new gasket material shall be used in the reconstruction.

5.10. Leak Testing

5.10.1. A visual or vacuum box leak test should be performed on the area of repair.

6 NAMEPLATES

6.1 Tanks that are repaired, altered, or reconstructed in accordance with 12R1 should be identified by a corrosion-resistant metal nameplate. The original nameplate shall remain in place (for historical reference)and the new nameplate placed adjacent to it. Letters and numerals not less than 4 mm ($^{5}/_{32}$ in.) high shall be embossed, engraved, or stamped on the nameplate to indicate information as follows:

a) compliance with the appropriate API 12 Series Specification;

b) reconstruction contractor;

c) year reconstruction was completed;

d) nominal diameter;

e) nominal shell height;

f) nominal capacity;

g) bottom thickness;

h) shell thickness;

i) design pressure;

j) shell material; and

k) Owner/Operator tank designation, if applicable.

The applied nameplate shall be consistent in design with that of the applicable standard.

ANNEX A
(informative)

Recommended Qualifications for Qualified Inspectors ~~and Qualified Condition Examiners~~

A.1 Qualified Inspector

A.1.1 Qualified Inspectors should have education and experience equal to at least one of the following:

a) a certified API Standard 653 inspector.
b) A certified API Standard 510 or 570 inspector, plus one year of experience with inspection or condition examination of storage tanks
c) a degree in engineering plus one (1) year of experience in fabrication or inspection of tanks or pressure vessels;
d) a two-year certificate in engineering or technology from a technical college, and two (2) years of experience in construction, repair, operation, or inspection, of which one year must be in inspection of tanks or pressure vessels; and/or
e) the equivalent of a high school education plus three (3) years of experience in construction, repair, operation, or inspection, of which one (1) year must be in inspection of tanks or pressure vessels.

A.1.2 In all cases, the Qualified Inspector shall have a working knowledge of the standard or specification originally used for the tank construction, and be capable ~~to be inspected and capability~~ to apply this document.

~~A.2 Qualified Condition Examiner~~

~~**A.2.1** A Qualified Condition Examiner for tank condition examination should have education and experience equal to the following:~~

~~a) a high school graduate or equivalent, and~~

~~b) a minimum of three (3) years of experience with construction, operation, repair or inspection of storage tanks or pressure vessels in oil field production, refining, petrochemical production, oil/fluid terminals, or other processing facility using storage tanks within the scope of this document., and~~

~~c) knowledge and understanding of the requirements and recommendations of this document.~~

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ANNEX B
(informative)

External Condition Examination Checklist			
Date of Inspection:		Inspected by:	
Construction Code:		Serial Number/Tag ID:	
Manufacturer:		Design Pressure:	
Year built:		Nominal Height:	
Tank Diameter:		Bottom Type:	
Nominal Roof Thickness:		Bottom Material:	
Nominal Shell Thickness:		Shell Material:	
Nominal Bottom Thickness:		Roof Material:	
Nominal Capacity (bbls):		Internal Lining Material:	
Content/Medium:			
Foundation Type: *(Circle whichever applicable)*	• Soil / Sand • Steel Rings / Soil • Concrete • Gravel • Pilings • Others:_____ □ Yes □ No		
Tank Elevated from ground:			

INSPECTION GUIDANCE:

i. Inspectors shall be knowledgeable of the purpose of each piece of equipment, method of operation, and if applicable, the manufacturers maintenance, inspection, testing requirements and instructions.

ii. This inspection does not require a certified inspector. It shall be performed by an owner's designated inspector who is familiar with the site and can identify changes and developing problems.

iii. The checklist items below are the minimum requirements for inspection; an individual tank may require more in-depth inspections. Conversely, some of the checklist items may not be applicable to an individual tank system.

iv. If any answers are "No", the aboveground storage tank in a non-conformance status. This indicates that action is required to address a problem. Document corrective actions in the comment section.

v. Non-conforming items important to tank or containment integrity (cracks, tank or containment deformation, etc.) require evaluation by an engineer experienced in AST design, a certified inspector, or a tank manufacturer who will determine the corrective action. Note the non-conformance and corresponding corrective action in the comment section

vi. If pitting* observed, describe pitting and define location using coordinates in remarks section.

Inspection Item	Description	Status			Comments
Foundation	a) Is the tank levelled?	Yes	No	N/A	
	b) Foundation and supports in good condition	Yes	No	N/A	
	c) Drainage directed away from base and bottom of tank	Yes	No	N/A	
	d) Tank/Nozzles is clear from any sign of leaks	Yes	No	N/A	
Secondary containment	a) Release protection barrier is free from holes or tears	Yes	No	N/A	
	b) Containment structures is clear from any sign of: • Delamination of Caulking • Paint Failure • Leakage • Holes • Washout • Tank Settlement	Yes	No	N/A	
	c) Birm/wall is free of low areas/damage and well maintained	Yes	No	N/A	
	d) Tank area free of buildup of trash, vegetation & other inflammables	Yes	No	N/A	
Bottom (For elevated tank)	a) Tank bottom is free from damages/leaks	Yes	No	N/A	
	b) External coating is in good condition	Yes	No	N/A	
Double wall tank	a) Gauge is fitted, readable and functional	Yes	No	N/A	
	b) Secondary containment is free of liquids	Yes	No	N/A	
Shell	a) Tank shell is level/plumb	Yes	No	N/A	
	b) External coating is in good condition	Yes	No	N/A	
	c) Shell is free from external corrosion and/or pitting*	Yes	No	N/A	
	d) Shell is free from any deformation: • Dents • Bulging • Buckling • Cracking	Yes	No	N/A	
	e) Welds are free of corrosion/cracking	Yes	No	N/A	
	f) Nozzles are free of distortion/stress	Yes	No	N/A	
	g) Nozzles free of corrosion	Yes	No	N/A	
	h) Nozzle welds free of corrosion/cracks	Yes	No	N/A	
	i) Nozzle bolting tight, free of corrosion and leaks	Yes	No	N/A	
	j) Manway free of distortion/corrosion	Yes	No	N/A	
	k) Manway bolting tight, free of corrosion and leaks	Yes	No	N/A	
	l) Insulation/Cladding is in good condition and free from:	Yes	No	N/A	
	m) Cladding is properly sealed • Missing sections • Areas of moisture • Mold • Damage	Yes	No	N/A	

Roof	a) Roof is in good condition and free of leakes	Yes	No	N/A	
	b) External coating is in good condition	Yes	No	N/A	
	c) Roof is free from external corrosion and/or pitting*	Yes	No	N/A	
	d) Frangible roof weld in good condition	Yes	No	N/A	
	e) Adequate drainage off roof deck	Yes	No	N/A	
Appertunances	a) Stairways/walkways/ladders structurally sound and free of corrosion	Yes	No	N/A	
	b) Thief/gauge hatch is operating properly and seals tight	Yes	No	N/A	
	c) Gauge board is secure and legible	Yes	No	N/A	
	d) Gauge cable is secure free of kinks and other damage	Yes	No	N/A	
	e) Dial gauges legible/functional	Yes	No	N/A	
	f) Normal Vent is operating properly and is in good condition	Yes	No	N/A	
	g) Vent valve seals tight	Yes	No	N/A	
	h) Vent is clear of obstructions	Yes	No	N/A	
	i) Overfill Protection is operating properly	Yes	No	N/A	
	j) Gas blanket is operating properly	Yes	No	N/A	
	k) All metal parts are properly bonded for fiberglass tank.	Yes	No	N/A	
	l) Connections and/or valves free from leaks	Yes	No	N/A	
	m) Proper warning signs in place	Yes	No	N/A	
	n) Cathodic protection system correctly installed and operational	Yes	No	N/A	
	o) Tank grounding connection is securely connected	Yes	No	N/A	
	p) Lightning protection system installed	Yes	No	N/A	
	q) Wiring and instrumentation securely connected	Yes	No	N/A	

ANNEX C
(informative)

Internal Condition Examination Checklist			
Date of Inspection:		Inspected by:	
Construction Code:		Serial Number/Tag ID:	
Manufacturer:		Design Pressure:	
Year built:		Nominal Height:	
Tank Diameter:		Bottom Type:	
Nominal Roof Thickness:		Bottom Material:	
Nominal Shell Thickness:		Shell Material:	
Nominal Bottom Thickness:		Roof Material:	
Nominal Capacity (bbls):		Internal Lining Material:	
Content/Medium:			
Foundation Type: *(Circle whichever applicable)*	• Soil / Sand • Steel Rings / Soil • Concrete • Pilings • Gravel • Others:_____		
Tank Elevated from ground:	□ Yes □ No		

INSPECTION GUIDANCE:

i. Inspectors shall be knowledgeable of the purpose of each piece of equipment, method of operation, and if applicable, the manufacturers maintenance, inspection, testing requirements and instructions.

ii. This inspection does not require a certified inspector. It shall be performed by an owner's designated inspector who is familiar with the site and can identify changes and developing problems.

iii. The checklist items below are the minimum requirements for inspection; an individual tank may require more in-depth inspections. Conversely, some of the checklist items may not be applicable to an individual tank system.

iv. If any answers are "No", the aboveground storage tank in a non-conformance status. This indicates that action is required to address a problem. Document corrective actions in the comment section.

v. Non-conforming items important to tank or containment integrity (cracks, tank or containment deformation, etc.) require evaluation by an engineer experienced in AST design, a certified inspector, or a tank manufacturer who will determine the corrective action. Note the non-conformance and corresponding corrective action in the comment section.

vi. If pitting* observed, describe pitting and define location using coordinates in remarks section.

Inspection Item	Description	Status			Comment
Bottom	a) Internal coating is in good condition	Yes	No	N/A	
	b) Bottom internal is free from corrosion and/or pitting*	Yes	No	N/A	
	c) Bottom internal is free from abnormalities or distortion	Yes	No	N/A	
	d) Bottom edge is free from settlement	Yes	No	N/A	
	e) Bottom is free from cracks or leaks	Yes	No	N/A	
Shell	a) Internal coating is in good condition	Yes	No	N/A	
	b) Shell internal is free from corrosion and/or pitting*	Yes	No	N/A	
	c) Shell internal is free from abnormalities or distortion	Yes	No	N/A	
	d) Shell weldment is in good condition	Yes	No	N/A	
	e) Shell is free from leaks	Yes	No	N/A	
	f) Edge settlement is in acceptable range	Yes	No	N/A	
	g) Internal nozzles welds free of cracks	Yes	No	N/A	
	h) Internal nozzles free of corrosion	Yes	No	N/A	
	i) Nozzle bolting free of corrosion	Yes	No	N/A	
	j) Nozzle bolting tight	Yes	No	N/A	
Roof	a) Internal coating is in good condition	Yes	No	N/A	
	b) Roof internal is free from corrosion and/or pitting*	Yes	No	N/A	
	c) Structural supports or rafters is in good condition	Yes	No	N/A	
	d) Roof is free from dents or distortions	Yes	No	N/A	
Appertunances	a) Cathodic protection system satisfactory	Yes	No	N/A	
	b) Internal piping free of corrosion/stress	Yes	No	N/A	
	c) Internal flanges secure and free of corrosion	Yes	No	N/A	
	d) Mechanical systems free of corrosion/damage	Yes	No	N/A	
	e) Mechanical systems is operating properly	Yes	No	N/A	
	f) Internal supports free of corrosion/damage	Yes	No	N/A	
	g) Previous steel repairs in good condition	Yes	No	N/A	
	h) Previous coating repairs in good condition	Yes	No	N/A	

ANNEX D
(normative)

Minimum Thickness for Tank Elements

D.1 Introduction

The following minimum thickness criteria for predicting the corrosion rate life of API Specifications 12B, 12D, and 12F tank elements is intended to provide at least five (5) years remaining life.

D.2 Tank Shell Course Minimum Required Thickness Determination

For steel API 12 Series standard tanks, the minimum required thickness for the plate in each shell course shall be determined using the following equation for Minimum Thickness Calculation from API Standard 653:

$$T_{\min} = \frac{2.6(D)(H-1)(G)}{(S)(E)}$$

where

T_{min} is the acceptable minimum thickness in the lowest three (3) inches of the shell as used in the prediction of corrosion rate life of the tank in inches;

D is the nominal tank diameter in feet;

H is the height of the liquid level above the bottom of the shell course under consideration in feet;

G is the design specific gravity of stored liquid (e.g. water = 1);

E is the joint efficiency:

— 1.0 for corroded plate in bolted tanks and corroded plate away from welds in welded tanks.

— 0.70 for unknown efficiency of welds.

— 0.85 or 1.00 for radiographed welds in accordance with normal design practice for the class, service, and manufacture of the tank;

S is the maximum allowable stress in pound force per square inch (lbf/in2); use the smaller of 0.80*Y* or 0.429T for bottom and second course; use the smaller of 0.88Y of 0.472T for all other courses

Y is the specified minimum yield strength for the material of construction (lbf/in2); use 30,000 lbf/in2 if not known.

NOTE *This formula permits calculation of thickness at 80 % of yield strength, which exceeds normal design practice for mechanical and structural elements in production facilities. It is intended for use in API Standard 12R1 to predict corrosion rate life. It is NOT intended to serve as design criteria for new features or as sole acceptance/rejection criteria.*

T is the smaller of the specified minimum tensile strength of the plate or 80,000 lbf/in2; use 55,000 lbf/in2 if not known

D.3 Suggested Remaining Minimum Thickness Calculations

D.3.1 For the tank elements shown in Figure D.1, the suggested remaining minimum thickness, ($T_{min.}$) is as follows:

a) Isolated Individual Pits:

T_{min}

is equal to 5 times the corrosion rate.

b) Tank Bottom:

1) Critical annular ring area:

— T_b^1 is equal to 0.50 T_{min} or a minimum of 0.062 in.

2) Primary bottom thickness:

— T_b^2 is equal to 5 times the corrosion rate or a minimum of 0.05 in.

$_{min}$ or a minimum of 0.062 in.

4.2.7 T^1 for the area around door sheet extending 3 feet on either side as well as 3 feet on the top is a minimum of 0.225 in

c) Tank Shell:

1) Ring #1:

— T_s^1 is equal to 0.75 T

2) Ring #2 and Ring #3:

— T^2 and T^3 values are equal to 0.50 T or a minimum of 0.062 in.

$_s$ $_s$ $_{min}$

d) Tank Roof: (access onto a tank roof after the tank has been placed in service is not recommended and should be avoided until it is known that the integrity of the roof is sufficient to prevent collapse)

1) Areas where personnel access is permitted only with walkboards or reinforcement.

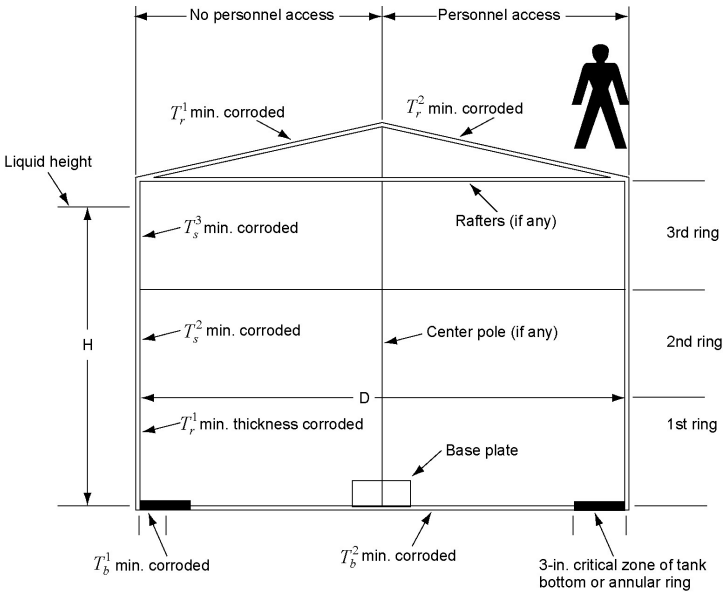
— T_r^1 is equal to 5 times the corrosion rate or a minimum of 0.05 in.

2) Areas where personnel access is permitted without walkboards or reinforcement.

— T_r^2 is equal to 0.09 in.

e) Center pole and rafters. These members must retain sufficient structural integrity to support live loads of 20 pounds/square foot.

D.3.2 Except for major foundation failure or major seismic activity failure, API design center poles and rafters rarely fail prior to roof or bottom failure. However, frequently rafter bolting failures (with subsequent falling rafters) occur concurrently with, or prior to, roof or bottom failure. Inspection intervals based on roof, shell and bottom failure should provide adequate information to ensure the structural integrity of these members.



NOTE See API 653 for welded steel tanks greater than 9.17 m (30 ft) in diameter.

Figure D.1—Corrosion Calculation Nomenclature

D.4 Corrosion Rate Life

D.4.1 The equation for computing the corrosion rate life of a given tank component is given as follows:

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

where

$T_{current}$ is the thickness measured at the time of inspection of the limiting section used in the determination;

$T_{minimum}$ is the minimum allowable thickness or the limiting section or zone.

D.4.2 The resultant corrosion rate life is used to establish the remaining life and inspection interval for the tank.

Table D.1—Summary of Minimum Thickness for Tank Elements

Element	T_{min}	Calculated Minimum	Absolute Minimum
Isolated Pits	—	5 × CR [a]	0.050 in.
Bottom			
Critical annulus	T_b^1	$0.50\,T_{min}$	0.062 in.

Table D.1—Summary of Minimum Thickness for Tank Elements (Continued)

Element	T_{min}	Calculated Minimum	Absolute Minimum
Primary section	T_b^2	5 × CR [a]	0.050 in.
Shell			
Ring #1	T_s^1	$0.75\ T_{min}$	0.062 in.
Ring #2 and Ring #3	$T_s^2 - T_s^3$	$0.50\ T_{min}$	0.062 in.
Roof Deck			
No access	T_r^1	5 × CR [a]	0.050 in.

[a] Applicable corrosion rate.

ANNEX E
(normative)

Walkways and Stairways

E.1 General

Walkways and stairways addressed in this specification shall be constructed from prefabricated components designed to be field erected alongside API 12 Series tanks. Walkways and stairways shall be designed in accordance with ANSI/AISC 360, *Specification for Structural Steel Buildings*, and ASCE 7-16, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. Additionally, walkways and stairways must comply with the jurisdictional requirements where the walkway and stairway will be erected, such as OSHA (Occupational Safety and Health Administration) 29 CFR Part 1910.

All material shall be steel in accordance with ASTM A36, or ASTM A1011, unless specified otherwise by the Purchaser. All steel components shall be galvanized, painted, or provided with a finish specified by the Purchaser.

NOTE The Purchaser should consider alternate materials or finishes for corrosive service environments (e.g. exposure to salt water or H_2S).

E.2 Terms and Definitions

E.2.1
guardrail
Personnel barrier erected along an unprotected or exposed side, edge, or other area of a walking-working surface or stairway to prevent falling outward.

E.2.2
handrail
Rail used to provide personnel with a handhold for support from the stairway.

E.2.3
mid-rail
Rail used to provide structural rigidity, as well as to prevent falls in the opening between the guardrail and the stairway or the walkway decking.

E.2.4
riser height
The vertical distance between the treads.

E.2.5
span
Distance between two intermediate supports for a structure.

E.2.6
stair nose
The leading edge of the stair tread.

E.2.7
stair tread
The horizontal portion of a set of stairs on which a person walks.

E.2.8
stringer
The support member of a stairway which supports the treads.

E.2.9
toe board
A low protective barrier that is designed to prevent materials, tools, and equipment from falling to a lower level, and protect personnel from falling objects.

E.2.10
tread depth
The horizontal distance from the leading edge of one stair nose to the vertical projection of the leading edge of the stair nose of the next step.

E.2.11
post
The structural support member that connects the walkway decking or stair stringer to the mid-rail and either the guard rail or the handrail.

E.2.12
walkway decking
The horizontal surface between handrails on a walkway where personnel walk, work, or gain access to a work area.

E.3 Structure Design

E.3.1 General

Walkways and stairways shall be designed by a competent person with appropriate structural licensure and qualifications in the jurisdiction where they will be installed, or as otherwise specified by the Purchaser.

E.3.2 Roof Access

Walkways and stairways shall be provided for personnel to access devices on the tank roof. These devices must be located within arms-reach of the platform. These structures are not intended to provide access onto the roof itself, unless specified by the Purchaser.

E.3.3 Manufacturing and Handling

The design of the walkways and stairways shall take into account lifting and rigging the walkway and stairway components into place. Walkway and stairway components shall be designed so they can be adequately disassembled and secured for transportation and quickly and easily be re-assembled.

E.3.4 Overhead Clearance

The Purchaser should consider clearance to overhead structures in the overall design of the system. Adequate head clearance between personnel and overhead structures such as piping should be accounted for. The minimum distance between the top of the walkway surface and the overhead obstruction shall be no less than 2 m (6 ft 8 in.).

E.4 Walkways

E.4.1 General

E.4.1.1 Walkways consist of a horizontal deck plate, posts, guardrail, mid-rail, and toe-boards (see Figure E.1).

E.4.1.2 A walkway that exceeds 6.1 m (20 ft.) shall have a means of egress so as to not create a dead-end that would impede evacuation in the case of an emergency.

E.4.1.3 Each unsupported span of a walkway shall be designed and assembled to support a uniform live load of 244 kg/m^2 (50 lb/ft^2) over its whole surface without deflecting more than 1/240 of the span length.

E.4.1.4 Each unsupported span of a walkway shall be designed and assembled to support a concentrated live load of 4.45 kg (1000 lb) at any point without deflecting more than 1/240 of the unsupported span length.

E.4.1.5 Foundations shall be suitably prepared and compacted to mitigate settlement. The Purchaser shall ensure that suitable foundations are in place based on soil bearing capacity. Foundations shall utilize piles, concrete blocks, baseplates, or other suitable support structures.

E.4.1.6 Walkways shall have a clear width of 700 mm (28 in.) (see Figure E.1). Guardrails, mid-rails, toe boards, hardware, and all other components shall not infringe on the clear width.

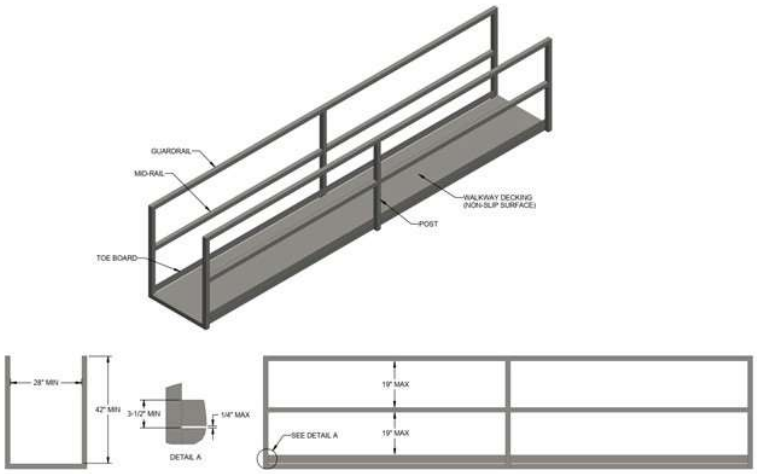


Figure E.1—Walkway Dimensional Requirements

E.4.2 Walkway Decking

E.4.2.1 Walkway decks shall be made of grating, expanded metal or other material having a non-slip surface or as otherwise specified by the Purchaser.

E.4.3 Walkway Guardrail

E.4.3.1 A guardrail shall be installed at a minimum height of 1,070 mm (42 in.) above the walkway deck. A handrail is not required on a walkway (see Figure E.1).

E.4.3.2 The guardrail shall be capable of withstanding a concentrated force of 890 N (200 lbf) applied in any direction at any point. The top rail of the guardrail system must not deflect to a height of less than 990 mm (39 in.) above the walking-working surface.

E.4.3.3 The edge of the walkway guardrail shall be smooth to prevent any snagging and injury.

E.4.3.4 A mid-rail shall be installed at a height midway between the top edge of the guardrail and the walkway deck (see Figure E.1).

E.4.3.5 Openings between rails or between a rail and the toe board shall not exceed 483 mm (19 in.) wide in the vertical direction (see Figure E.1) Additional mid-rails shall be required if the guardrail is elevated higher than the minimum requirement.

E.4.3.6 Where mid-rails project into walkways, the ends shall be contoured to prevent snagging and injury to personnel.

E.4.3.7 Mid-rails shall be capable of withstanding a concentrated force of 667 N (150 lbf) applied in any direction at any point.

E.4.3.8 Guardrails shall be 30 mm (1 $^{1}/_{4}$ in.) in diameter if made of pipe and a minimum thickness of 6 mm ($^{1}/_{4}$ in.) if made of angles, channels, or other similar structural sections.

E.4.3.9 Mid-rails shall be 30 mm (1 $^{1}/_{4}$ in.) in diameter if made of pipe and a minimum thickness of 6 mm ($^{1}/_{4}$ in.) if made of angles, channels, or other similar structural sections. Other sections may be considered if structurally equivalent.

E.4.4 Toe Boards

E.4.4.1 Toe boards shall be installed on all open sides (except at the entrance of stairways or ladders).

E.4.4.2 The top edge of toe boards shall be a minimum of 88 mm (3.5 in.) above the walking surface (see Figure E.1)

E.4.4.3 The bottom edge of toe boards shall be a maximum of 6 mm (0.25 in.) above the walking surface (see Figure E.1)

E.4.4.4 Toe boards shall have no gaps along their length greater than 25 mm (1 in.).

E.4.4.5 Toe boards shall be capable of withstanding a concentrated force of 222 N (50 lbf) applied in any direction at any point.

E.5 Stairways

E.5.1 General

E.5.1.1 Stairways shall consist of stair stringers, stair treads, posts, handrails, mid-rails, and guardrails (see Figure E.2).

E.5.1.2 Each unsupported span of a stairway shall be designed and assembled to support a uniform load of 488 kg/m^2 (100 lb/ft^2) over its whole surface without deflecting more than 1/240 of the span length.

E.5.1.3 Each unsupported span of a stairway shall be designed and assembled to support a concentrated load of 4.45 kg (1,000 lbf) at any point without deflecting more than 1/240 of the span length.

E.5.1.4 Stairways shall have an angle between 30° and 50° from horizontal (see Figure E.2).

E.5.1.5 Riser height shall be a minimum of 165 mm (6.5 in.), and a maximum of 240 mm (9.5 in.) (see Figure E.2). The height of each riser shall be uniform throughout the run of the stairway.

E.5.1.6 Tread depth shall be a minimum of 240 mm (9.5 in.) (see Figure E.2). The depth of each tread shall be uniform throughout the run of the stairway.

E.5.1.7 An intermediate landing shall be supplied where the maximum continuous vertical height of a stairway exceeds 7.3 m (24 ft), or as otherwise specified by the Purchaser, and in accordance with applicable code requirements.

E.5.1.8 If an intermediate landing is required, the platform shall be in accordance with E.4. The landing shall have a depth of not less than 762 mm (30 in.) as measured in the direction of travel.

E.5.1.9 Stairways shall have a clear width of 700 mm (28 in.) (see Figure E.2). Handrails, guardrails, mid-rails, hardware, conduit, piping, valves, appurtenances, and all other components shall not infringe on the clear width.

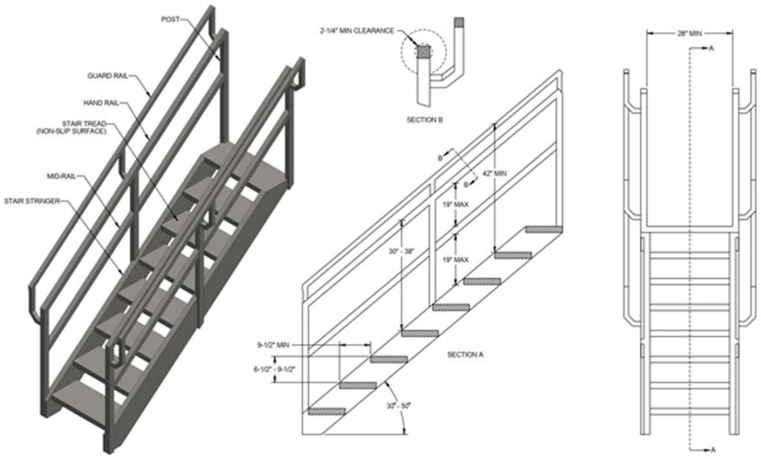


Figure E.2—Stairway Dimensional Requirements

E.5.2 Stair Treads

E.5.2.1 Stair treads shall be made of grating, expanded metal or other material having a non-slip surface. The stair nose shall have a non-slip finish.

E.5.3 Stair Guardrail and Handrail Systems

E.5.3.1 Stairways shall have dedicated guardrails and handrails (see Figure E.2).

E.5.3.2 Stair guardrails shall be installed on both sides of stairways and be able to withstand 890 N (200 lbf) force at any point along the top rail. The top rail of the guardrail system must not deflect to a height of less than 990 mm (39 in.) above the walking-working surface.

E.5.3.3 Handrails shall not be less than 760 mm (30 in.) or more than 965 mm (38 in.) above the stair nose. (see Figure E.2).

E.5.3.4 Clearance between the handrail and the guardrail supports for finger clearance shall be at least 57 mm (2 1/4 in.) (see Figure E.2).

E.5.3.5 Openings in the stair railing system shall not exceed 483 mm (19 in.) wide in the vertical direction (see Figure E.2).

E.5.3.6 The edge of stair guardrails and handrails shall be smooth to prevent any snagging of clothing, catching, or possible injury from sharp non smooth edges, splinters, or anomalies.

E.5.3.7 No part of the stair guardrail shall be removable during normal service.

E.5.3.8 Where mid-rails project into stairways, the ends shall be contoured to prevent snagging and injury to personnel.

E.6 Bolting

E.6.1 General

E.6.1.1 Bolting shall consist of flange bolting and flange nuts or heavy hex bolting, heavy hex nuts, and flat washers.

E.6.1.2 Bolting that can regularly come in contact with personnel, such as on handrails and guardrails shall have round heads such as carriage bolts, button head bolts, or pan head bolts.

E.6.2 Materials

E.6.2.1 Flange bolts and nuts shall comply with SAE J429 Grade 5.

E.6.2.2 Heavy hex bolts shall comply with ASTM A307, A193M/A193, or F3125 Class A325, and conform to ASME B18.2.1.

E.6.2.3 Heavy hex nuts shall comply with ASTM A563 or ASTM A194.

E.6.2.4 Washers shall comply with ASTM F844 or F436.

E.6.3 Finish

E.6.3.1 Consideration should be given to service and location to determine material or coatings, or both, for corrosion protection.

E.6.3.2 If bolts, nuts, and washers are galvanized, they shall comply with ASTM F2329 or the Purchaser's specification.

E.6.4 Bolting Installation

Bolting installation shall comply with ANSI/AISC 360.

E.6.5 Anchor Bolts

Anchor bolts shall comply with the AISC *Steel Construction Manual* and ACI 318.

ANNEX F
(informative)

Figures and Diagrams

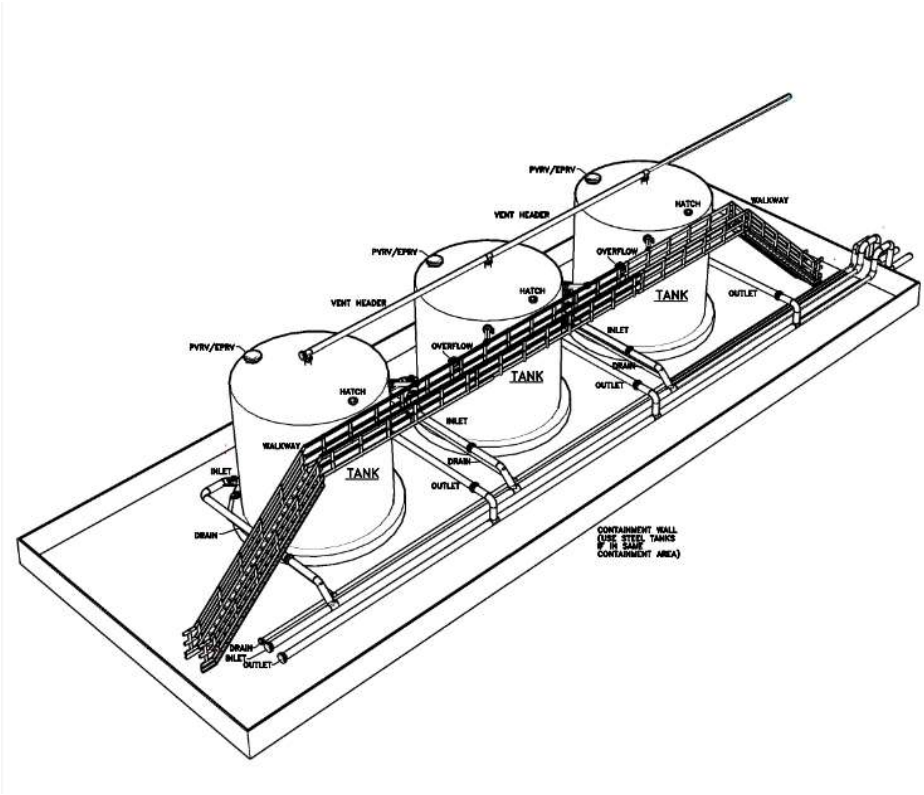


Figure F.1—Example of Straight-line Tank Battery Installation and Piping Configurations

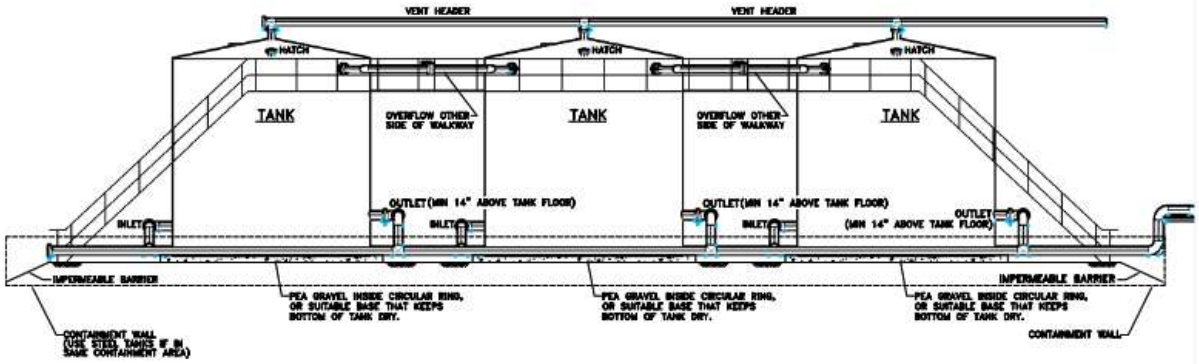


Figure ~~F.3A~~F.2A—Example Tank Battery Installation Elevation Showing Dike and Example Piping Configuration

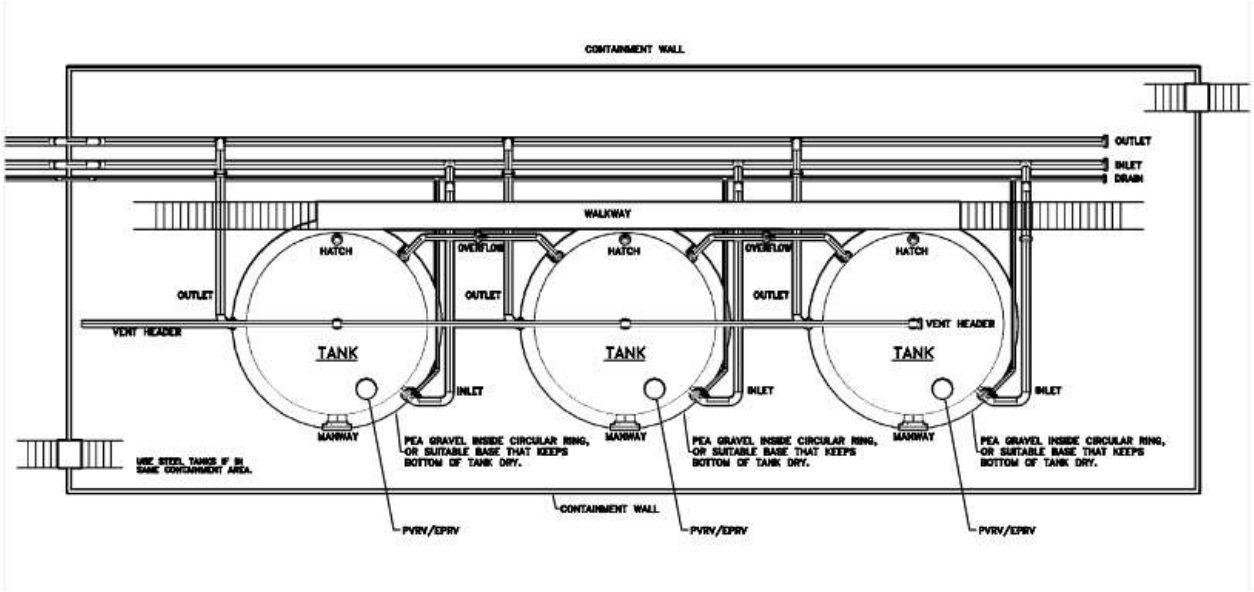


Figure ~~F.3B~~F.2B—Example Tank Battery Installation Top View Showing Dike/ and Example Piping Configuration

ANNEX G
(informative)

Unmanned Upstream Facility Design and Safety Considerations

G.1 General Public Safety

G.1.1 This annex should be considered as a guide for the design and security of storage tanks at unmanned E&P facilities for all produced fluids. It contains recommendations for practices when such facilities may be subject to tampering or introduction of ignition sources by members of the public which could result in a tank explosion or other accidental release to the environment.

G.1.2 In addition to the guidelines set out in this standard, public education and awareness of the dangers of unmanned storage tanks should be taken into consideration. Although public education through local schools does exist in some areas where these facilities are located, it is important to ensure these dangers are part of a company community awareness plan that fosters engagement with the workforce and communities, non-governmental organizations, government and regulatory authorities and other appropriate stakeholders to address potential security, safety, health, environmental, social and other concerns.

NOTE See API HF4 for more information on community engagement programs and activities.

G.2 Facility Security Assessment

The operator should perform an assessment to determine the appropriate level of security necessary to deter access by unauthorized persons to the facility and options to control vapor releases. This facility security assessment should include the following:

a) mitigation of vapor releases;

b) facility barricades; and

c) facility signage.

G.3 Considerations to Mitigate Vapor Releases

G.3.1 General

To reduce the likelihood of explosions, the use of the following design features should be considered in lieu of open vents for flammable hydrocarbons:

a) pressure vacuum vent valves,

b) flame arrestors,

c) vapor control systems,

d) floating roofs,

e) blanket gas,

f) an equivalent alternative to items a) through e).

G.3.2 Pressure Vacuum Relief Valves

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Pressure vacuum relief valves should be installed in lieu of an open vent. While the function is to minimize evaporation losses in a fixed roof tank, they also help ~~act~~ to effectively reduce ignitable vapor clouds ~~isolate ignition sources, acting as a type of flame arrestor~~. They are not designed to be used as a flame arrestor. See API Standard 2000, API Standard 520, API Standard 521, and API Standard 526 for more information on tank venting and pressure relief valve design.

G.3.3 Flame Arrestors

G.3.3.1 A flame arrestor is a device that uses a tortuous path to inhibit the propagation of a flame into a flammable environment. They can effectively prevent flame transmission from atmospheric explosions that occur near tank vents that are outbreathing or leaking.

G.3.3.2 Inline detonation flame arrestors offer protection to tanks connected via vapor collection systems whether they are simple or complex. Special considerations should be made for complex vapor headers to ensure proper device selection (ex. change in pipe diameter~~),.~~ A flame arrestor should be installed on each tank connected to the vapor control system to prevent a flashback from spreading via the vapor line~~.~~.

G.3.3.3 If installed on pressure vacuum valves, flame arrestors shall be maintained and cleaned periodically to remove any obstructions, such as dust, and heat tracing used~~,~~ to prevent ice build-up. This is to avoid the risk of tank collapse due to a pressure problem during operation. ~~When devices are used in combination they shall have 3rd party documentation to verifying proper valve function, flow rates, and flashback protection.~~ ***When a venting device is used in combination with a flame arrestor or detonation arrestor, both devices shall be manufactured by the same manufacturer and they shall be certified by the manufacturer for proper application, flow rates, and flashback protection***.

NOTE See API Recommended Practice 2210 for more information on flame arrestors for vents.

G.3.4 Vapor Control System

For tanks in E&P service, consideration should be given to using a vapor control system such as a vapor recovery unit (VRU), a combustor, or a flare, where applicable. Vapor control systems control vapors from the tank where the gasses can be collected and either recovered or burned. Blanket gas should be considered with use of a closed vent vapor control system to keep air out of the tank(s).

G.3.5 Floating Roof

The use of a floating roof can reduce the likelihood of a vapor space explosion, however, the practicality of using them on API 12 Series tanks should be considered. Floating roof tank designs for the E&P environment can be problematic for the following reasons:

a) on tanks with a diameter under 9.17 m (30 ft), there is not enough surface area to properly float the roof;

b) gas pockets created beneath the floating roof which can impede the function of the roof; and

c) in applications where the tank is relocated, the floating roof seal may need to be repaired or replaced.

G.3.6 Blanket Gas

G.3.6.1 The use of a blanket gas system to keep the vapor space under a slight positive pressure should be considered for storage tanks without a vapor control system. A blanket gas system should be used on tank with a vapor control system to prevent ingress of air. Blanket gas should only be used on tanks equipped with a pressure vacuum vent; however, the operator should evaluate the impact on emissions.

G.3.6.2 The positive pressure of the blanket gas can ensure that the vapor space remains oxygen deficient and above atmospheric pressure at all times, thereby preventing the creation of a combustible mixture (should air be ingested) that can lead to an explosion in the event of a spark or flame, or heating associated with compression (VRU).

G.3.6.3 Production tanks can have a supply of gas on site which could be routed to the tank vapor space after a reduction in pressure. Given their very low set points (often in inches of water column), the blanket gas pressure regulator should be installed near the top of the tank. The pressure regulator should be self-draining into the tank to minimize the chance for shutoff caused by hydrostatic head resulting from liquid accumulation in the line (should it be installed at the base of the tank).

G.3.6.4 Procedures should be developed to address safety during gauging for tanks operating under a blanket gas system or with a vapor control system.

G.4 Barricades

G.4.1 General

Based on proximity to populated areas and a facility security assessment conducted by the operator, barricades should be considered for installation at the bottom of stairways and ladders leading to the top of produced fluid tanks to restrict access. Other precautions based on the facility security assessment can include lockable thief/ gauge hatches, perimeter fencing, security systems, etc.

G.4.2 High Risk Facilities

At any facilities deemed high risk areas based on proximity to populated area or facility security assessment conducted by the company, the tank and equipment areas shall have lockable perimeter fences and sufficient warning signs as a minimum to deter access by unauthorized persons, especially children. This gated and locked perimeter fence(s) may be around the tanks, equipment, or the whole facility pad. The fence and gate should be 2.1 m (7 ft) high, latchable, and be of chain link material or equivalent. The operator should determine if the gate should be locked based on the facility security assessment.

G.4.3 Low Risk Facilities

Tanks in areas deemed as low risk areas based on the facility security assessment, should have a gate installed at the bottom of the stairway that is the same height as the stairway rails (see Figure G.1 and Figure G.2). Gates, at a minimum, should have three cross rails similar to the stairway. Gates should be latchable but are not required to be lockable. Signage requirements for these gates can be found in G.4.

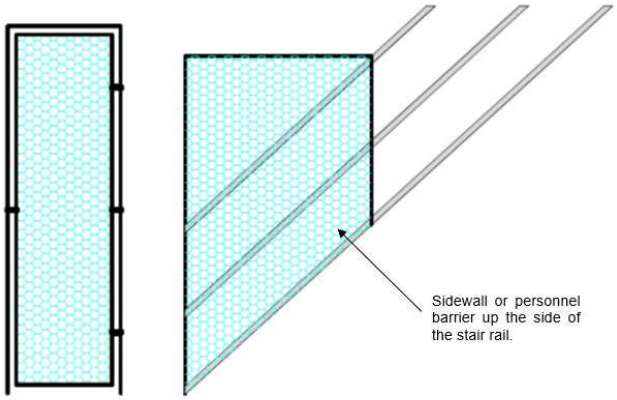


Figure G.1—Full Size Gate

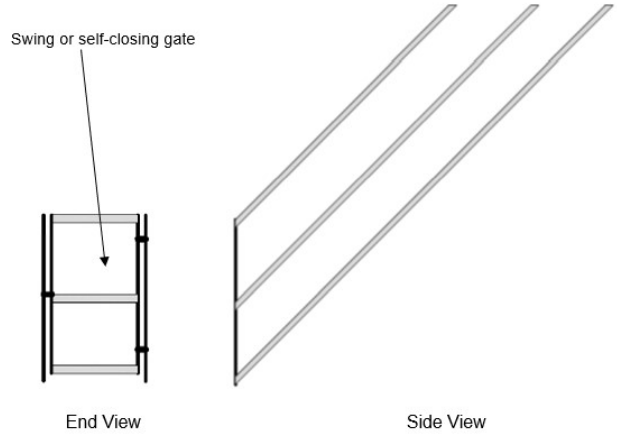


Figure G.2—Half Size Gate

G.5 Signage

G.5.1 In order to caution the public, employees, and contractors of the dangers on E&P facilities, operators should assess their work sites to evaluate the types of hazards present at their facilities. Signage representing the types of hazards should be displayed prominently at the entrance to the facility as well as at the bottom of stairways, barricades, and ladders where required.

See API 74 for examples of facility signs.

G.5.2 Where it is not required by 29 CFR 1910.145 (OSHA requirements), signage of this nature should be present as a control to potential incidents around oil and gas production and storage facilities including no trespassing, no smoking, and flammable material signs.

NOTE Local or state regulations may dictate additional signage requirements. See OSHA signage requirements.

G.5.3 Based on material(s) in the tank(s), signage placed on the gate to the entrance of the tank(s) should include, but is not limited to, the following:

a) no trespassing,

b) no smoking,

c) no open flames,

d) flammable gas present,

e) explosive vapors present,

f) poison gas present (H_2S).

G.5.4 Examples of signage are shown in Figure G.3.

No Trespassing

Fuel Storage, No Smoking

No smoking, No Open Flames, No Sparks

Flammable Gas

Explosive Vapor

H_2S

+, Poisonous Gas May Be Present

Figure G.3—Examples of Signage

G.6 Leases

New or revised surface leasing agreements should include security and signage requirements as described above.

ANNEX H
Existing Tank Re-rating for Higher Pressure

1.0 General

1.1 Scope

This annex offers guidance for Owner/Operators considering the rerating of their existing 12 series tanks. The rerating process should adhere to the ASME Boiler and Pressure Vessels Section VIII Division 2 – Alternative Rules (ASME VIII-2). Detailed assessment procedure utilizing the results from a stress analysis are provided to evaluate the tank for plastic collapse, local failure and buckling.

All stipulations in the main body of this Standard must be followed, except for those explicitly mentioned in this Annex.

NOTE: The rerating analysis must be conducted by an engineer with expertise in finite element analysis.

1.2 Applicability

The guidelines presented here are for tanks manufactured or fabricated as per API 12F and API 12D specifications.

Tanks with details identical to those specified in Figure 1 have already undergone a comprehensive FEA study. For such tanks, rerating to a design internal pressure of 16 ounces per square inch and an emergency internal pressure of 24 ounces per square inch is permissible without the need for additional analysis.

1.3 Protection Against Failure Modes

The analysis requirements are provided for protection against the failure modes listed below. If multiple assessment procedures are provided for a failure mode, only one of those procedures must be satisfied to rerate the tank. In addition, the component shall be evaluated for the following failure mode.

a) Protection Against Plastic Collapse- Requirement of paragraph 2.0 shall be satisfied.
b) Protection Against Local Failure- Requirement of paragraph 3.0 shall be satisfied.
c) Protection Against Collapse from Buckling- Requirement of paragraph 4.0 shall be satisfied.

1.4 Applicable Load Case and Combination

1.4.1 Loads

a) Dead weight (D)
b) Product hydrostatic pressure (P_s)
c) Internal pressure (P)
d) External pressure (P)

1.4.2 Load cases

a) Elastic Analysis: $P+P_s+D$
b) Limit Load Analysis:
   i. Global Criteria: 1.5($P+P_s+D$)
   ii. Local Criteria: 1.7($P+P_s+D$)
c) Elastic-Plastic Analysis:
   i. Global Criteria: 2.5($P+P_s+D$)
   ii. Local Criteria: 1.7($P+P_s+D$)

2.0 Protection Against Plastic Collapse

2.1 Overview

Three alternative analysis methods are provided in VIII-2, Part 5 for evaluating protection against plastic collapse. A brief description of the analysis methods is provided below.

Elastic Stress Analysis Method - Stresses are computed using an elastic analysis, classified into categories, and limited to allowable values that have been conservatively established such that a plastic collapse will not occur.

b) Limit-Load Method - A calculation is performed to determine a lower bound to the limit load of a component. The allowable load on the component is established by applying design factors to the limit load such that the onset of gross plastic deformations (plastic collapse) will not occur.

c) Elastic-Plastic Stress Analysis Method - A collapse load is derived from an elastic-plastic analysis considering both the applied loading and deformation characteristics of the component. The allowable load on the component is established by applying design factors to the plastic collapse load.

2.2 Elastic Stress Analysis Method

a) Assessment procedure - The assessment procedures for the Elastic Stress Analysis Method including the basis for determining stresses based on elastic analysis, stress categorization, and linearization shall be in accordance with VIII-2, Part 5, paragraph 5.2.2 except that the load combination given in section 1.4.2 shall be used.

b) Allowable Equivalent Stress - The allowable equivalent stress, S, shall be from the original code of construction.

2.3 Limit-Load Analysis Method

a) Assessment procedure - The assessment procedures for the Limit-Load Analysis Method shall be in accordance with VIII-2, Part 5, paragraph 5.2.3 except that the load combination given in section 1.4.2 shall be used,

2.4 Elastic Stress Analysis Method

a) The assessment procedures for the Elastic-Plastic Analysis Method shall be in accordance with VIII-2, Part 5, paragraph 5.2.4 except that the load case combinations in section 1.4.2 shall be used in the assessment.

2.5 Treatment of the Weld Joint Efficiency

The weld joint efficiency is included in the analysis through the following approach:

- Elastic Stress Analysis - The material allowable stress is reduced by multiplying by the governing weld joint efficiency.
- Limit Load Analysis - The limit load is computed and subsequently reduced by the governing weld joint efficiency.

- Elastic-Plastic Analysis - The load multipliers on sustained loads as defined in paragraph 1.4.2 are increased by multiplying by the inverse of the governing weld joint efficiency prior to determination of the plastic collapse load. The material true stress-strain curve is unaffected.

3.0 Protection Against Local Failure

3.1 Overview

In addition to demonstrating protection against plastic collapse as defined in paragraph 2.0, the applicable local failure criteria below shall be satisfied for a component. Two analysis methodologies are provided for evaluating protection against local failure to limit the potential for fracture under applied design loads.

a) Elastic Analysis Method - An approximation of the protection against local failure based on the results of an elastic analysis

b) Elastic-Plastic Analysis Method - A more accurate estimate of the protection against local failure of a component is obtained based on the results of an elastic-plastic stress analysis.

If a limit load analysis is used to evaluate protection against plastic collapse, the elastic-plastic analysis method for local failure shall be used to evaluate protection against local failure.

3.2 Elastic Stress Analysis Method

The assessment procedures for the Elastic Analysis Method shall be in accordance with VIII-2, Part 5, paragraph 5.3.2. except that the load case combinations shall be as per section 1.4.2

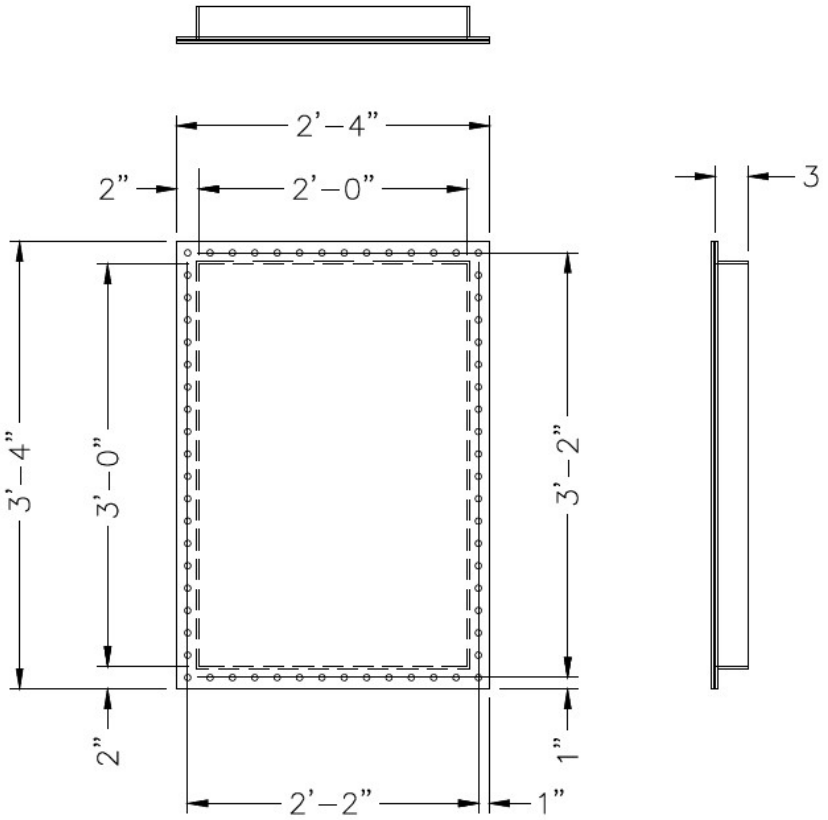
3.3 Elastic-Plastic Stress Analysis Method

The assessment procedures for the Elastic-Plastic Analysis Method shall be in accordance with VIII-2, Part 5, paragraph 5.3.3 except that the load case combinations shall be as per section 1.4.2

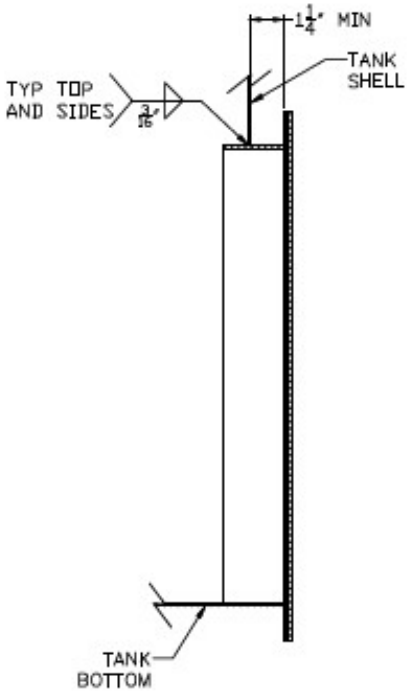
4.0 Protection Against Collapse From Buckling

4.1 Assessment Procedure

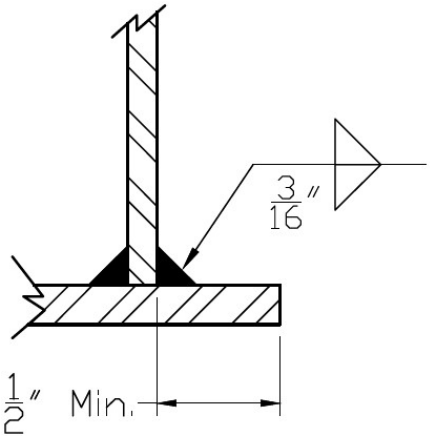
The assessment procedures for Protection Against Collapse from Buckling shall be in accordance with VIII-2, Part 5, paragraph 5.4 except that the load combination as shown in Section 1.4.2 (a) in a Type 1 or Type 2 assessment, and that the load case combinations in Section 1.4.2 (b) shall be used in a Type 3 assessment



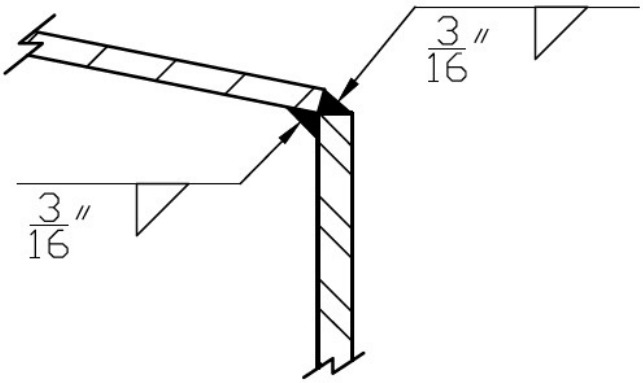
(a) Cleanout assembly overview



(b) Cleanout assembly side view with welding details



(c) Shell-to-bottom junction welding detail



(d) Roof-to-shell welding details

Figure 1 : API 12F detailed junction drawings

ANNEX J

Inquiries and Suggestions for Change

J.1 Introduction

This annex describes the process established by API for 1) submitting inquiries to API and 2) for submitting suggestions for changes to this standard. Inquiries and suggestions for change are welcome and encouraged, because they provide useful reader feedback to the responsible API Committee regarding technical accuracy, current technology use, clarity, consistency, and completeness of the standard. API will attempt to answer all valid inquiries. Submittals not complying with this annex will be returned unanswered.

Sections H.2 through H.8 address the submitting of inquiries. See Section H.9 for instructions about submitting suggestions for change.

J.2 Inquiry References

H.1.1 API maintains several websites that provide information that should be reviewed before submitting an inquiry.

H.1.2 Your inquiry may have been previously addressed by the Subcommittee and the resulting interpretation posted on the API website as follows:

— For all standards: http://mycommittees.api.org/standards/techinterp/default.aspx

— For Refining Standards: http://mycommittees.api.org/standards/techinterp/refequip/default.aspx

— For both links, click on the standard in question to download the file.

H.1.3 In addition, an addendum, or errata, which may have addressed your issue, can be found on the API website as follows:

— For all standards: http://www.api.org/standards/addenda/

— For Refining Standards: http://www.api.org/standards/addenda/add-ref.cfm

J.3 Terms and Definitions

H.3.1
inquiry
A question that asks, “what is the meaning of a specific paragraph, figure, or table in the standard”, i.e. what do the words say. It is not a question that asks about the intention of the standard.

H.3.2
interpretation
The answer to the inquiry. Typically, the answer is simply a “Yes” or “No” response, with a brief clarification if needed. This term is also used to refer to the combined question and answer.

H.3 API Policy Regarding Inquiries

H.3.1 API has established the following limits on its activity in the handling of inquiries.

a) API does not approve, certify, rate, or endorse any item, construction, proprietary device, or activity.

b) API does not act as a consultant on specific engineering problems.

c) API does not provide information on the general understanding or application of the standard.

H.3.2 All inquiries and resulting interpretations will be made available to the public on the API website.

H.5 Submission of Inquiries

H.5.1 An electronic form for submitting a request can be found on the API Website at http://rfi.api.org/. Please use this means to submit your inquiry.

H.5.2 All inquiries must comply with the following.

a) Current Standard: If an inquiry refers to a version or addendum that is not the latest, the Subcommittee will develop the interpretation based on the requirements stated in the current version.

b) Specific Reference: The applicable paragraph number, figure number, or table number must be cited in the inquiry.

c) Sentence Structure: Inquiries must be written such that the answer can be a YES or NO, with technical details added if necessary. The inquiry statement should be technically and editorially correct and written in understandable English.

d) Background: Providing a background explanation is optional but is encouraged to assist the committee in understanding the query.

e) Single Subject: The scope of an inquiry shall be limited to a single subject or a group of closely related subjects.

f) General Format:

1. The general format of the inquiry should be as follows: “Does Paragraph XXX of API-6XX require that ….?”

2. The inquirer shall state what is required in his or her opinion, as the answer to the query.

3. If a revision to the standard is believed to also be needed, provide recommended wording.

g) The Inquirer should not use the inquiry process to improve his general understanding, design skills, and usage of the standard. Consultants not affiliated with API are available for this purpose.

h) It is important that the Inquirer understand the difference between an inquiry and a suggestion for change. API encourages both, but the submittal and committee handling procedures are different.

H.5.3 General guidelines for submission can also be found on the API website at:

http://www.api.org/products-and-services/standards/standards-inquiries

H.6 Typical Inquiry Procedure

H.6.1 The typical procedure of an inquiry is as follows:

a) The Inquirer must prepare the inquiry, including any necessary background information, in full compliance with this annex and submit to the API Standards Coordinator.

b) API Standards Coordinator checks the inquiry to verify compliance with the requirements of submitting an inquiry.

c) If the inquiry cannot be answered for any reason, the Coordinator will issue a response to the inquirer advising the reason(s) for not answering the inquiry. A form or checklist will typically be used for this response.

d) If the Coordinator believes the inquiry is valid, it will be forwarded to the Subcommittee for study, and the inquirer will be so advised using the form letter.

e) The Subcommittee will evaluate the inquiry and either develop a response or determine that the inquiry cannot be answered and advise the Coordinator accordingly. The Subcommittee will consider the need for modifying the standard to resolve technical issues, add new requirements, make editorial corrections, improve clarity, remove conflicts, etc.

f) The interpretation will be published on the API website when approved by the Subcommittee.

H.6.2 The time required to process a valid inquiry as described in 6.1 may take as long as a year.

H.7 Interpretations Responding to Inquiries

H.7.1 An interpretation is written by the Subcommittee to provide the specific answer to an inquiry. It typically will not state the intent of the standard, nor give reasons for the requirements, nor give historical bases, nor provide overall understanding of the standard. If the inquiry is properly phrased, the interpretation can be a one-word response. With many inquiries, there may be a need to provide clarifying statements such as the limits on the applicability.

H.7.2 Although it is not possible to develop interpretations quickly to remedy immediate needs, the industry benefits entirely when inquiries are used as a means of trying to understand the technical requirements in the standard.

H.8 Form Response Sent to Inquirer

H.8.1 A form letter or email will be used to reply to inquirers indicating the action taken by API, and if applicable, the reason(s) for not being able to accept the inquiry.

H.8.2 Reasons for not being able to accept an inquiry may include the following:

a) Not Current Standard

b) No Specific Reference

c) Unclear Sentences

d) Inadequate Background Information

e) Unrelated Subjects

f) Format

g) Application to a Specific Tank

h) Consultant Question

H.9 Suggestions for Changes

H.9.1 A "Suggestion for Change" is not an inquiry; it is a type of communication (email preferred) from a customer to API proposing that a specific change be made to the standard.

H.9.2 Any format is acceptable, if the content is clear.

H.9.3 The most effective means to submit suggestions is to send an email to the API Coordinator (standards@api.org).

H.9.4 The content of a suggestion must include the standard number, edition, and addendum in question. The relevant paragraph numbers, table number, figure number, etc. must also be stated. Provide as much explanation as necessary to be sure the Subcommittee understands the technical issues. Provide specific language that you think is needed to implement the change. Last, include your name, company affiliation if any, and your return email or mailing address.

H.9.5 API will forward all suggestions that are suitably written to the Subcommittee for consideration. The Subcommittee will evaluate each suggestion and determine if a change is needed. Suggestions that are accepted by the Subcommittee will be reflected in a future edition or addenda, but a reply advising the submitter of the Subcommittee's decision may not be issued.

BIBLIOGRAPHY

The following bibliography is not all inclusive, but list informative documents referenced within API Standard 12R1:

[1] API Publication E5, *Environmental Guidance Document: Waste Management in Exploration and Production Operations*

[2] API Bulletin D16, *Suggested Procedure for Development of Spill Prevention Control and Countermeasures Plans*

[3] API Recommended Practice 74, *Recommended Practice for Occupational Safety for Onshore Oil and Gas Production Operation*

[4] API Recommended Practice 500, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division I and Division 2*

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[6] API Recommended Practice 520, *Sizing, Selection, and Installation of Pressure—Relieving Devices in Refineries—Part 1, Sizing and Selection*

[7] API Recommended Practice 575, *Inspection of Atmospheric and Low-Pressure Storage Tanks*

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[16] FTPI RP 2007-1 [5] , *Recommended Practice for the In-service Inspections of Aboveground Atmospheric Fiberglass Reinforced Plastic (FRP) Tanks and Vessels*

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[6] NACE International, P.O. Box 218340, Houston, Texas 77218, https://www.nace.org/home.

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7 Petroleum Equipment Institute, 6514 E. 69th Street, Tulsa, Oklahoma 73133.
8 Society of Petroleum Engineers, P.O. Box 833836, Richardson, Texas 75083-3836.
9 TAPPI, 15 Technology Parkway South, Suite 115, Peachtree Corners, Georgia 30092.

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