Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

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1 Scope

1.1 General

This standard is applicable to stationary atmospheric and low-pressure (up to and including 15 psig) aboveground petroleum storage tanks used in all sectors of the petroleum and petrochemical industry, including:

— crude oil and gas production,

— refining,

— petrochemicals,

— pipelines and terminals,

— bulk storage,

— ethanol facilities.

This standard provides requirements for safely planning, coordinating, and conducting tank entry and cleaning operations, from removal from service through return to service.

This standard does not and cannot cover every possible unique hazard or situation that may arise during tank cleaning operations. Site, product, and tank-specific hazards and situations must be addressed by employers using the appropriate principles and considerations provided for by this standard.

1.2 Non-applicability and Other Tank Cleaning Applications

This standard does not apply to the following types of tanks or vessels:

— pressure vessels and pressurized tanks exceeding 15 psig,

— cryogenic or refrigerated vessels or pressure tanks,

— vessels and tanks maintained under a vacuum,

— process vessels,

— underground storage tanks.

Although API Standard 2015 is not intended to cover these types of tanks and vessels, many of the safe tank cleaning and entry principles and requirements in this standard apply and should be considered.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Bulletin E2, *Bulletin on Management of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Production*

API Standard 650, *Welded Tanks for Oil Storage*

API Standard 653, *Tank Inspection, Repair, Alteration and Reconstruction*

API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

API Recommended Practice 2009, *Safe Welding, Cutting and Hot Work Practices in the Petroleum and Petrochemical Industries*

API Recommended Practice 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*

API Publication 2026, *Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum* Service

API Recommended Practice 2027, *Ignition Hazards and Safe Work Practices for Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*

API Publication 2202, *Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks*

API Recommended Practice 2207, *Preparing Tank Bottoms for Hot Work*

API Publication 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*

API Publication 2219, *Safe Operating Guidelines for Vacuum Trucks in Petroleum Service*

API Recommended Practice 2220, *Improving Owner and Contractor Safety Performance*

ACGIH [1], *TLVs and BEIs Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*

ANSI Z49.1 [2], *Safety in Welding, Cutting, and Allied Processes*

ANSI Z88.1, *Respiratory Protection against Radon Daughters*

ANSI Z88.6, *Respiratory Protection—Respirator Use—Physical Qualifications for Personnel*

ANSI Z88.10, *Respirator Fit Testing Methods*

ANSI Z117.1, *Safety Requirements for Confined Spaces*

CGA G-7.1 [3], *Commodity Specification for Air*

ICS, IAPH, and OCIMF; ISGOTT [4], *International Safety Guide for Oil Tankers and Terminals*

NFPA [5], *Fire Protection Handbook*

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1 American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, Ohio 45240-1634, www.acgih.com.

2 American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, New York 10036, www.ansi.org.

3 Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, Virginia 20151, www.cganet.com

4 International Chamber of Shipping, 38 St Mary Axe, London, EC3A 8B, www.ics-shipping.org.; International Association of Ports and Harbors, 7th Floor, South Tower New Pier Takeshiba 1-16-1 Kaigan, Minato-ku, Tokyo 105-0022 Japan, www.iaphworldports.org.; Oil companies International Marine Forum, 27 Queen Anne's Gate, London, SW1H9BU, England, www.ocimf.com.; Available from: Witherby Seamanship, Witherby Seamanship International Ltd, 4 Dunlop Square, Deans Estate, Livingston EH54 8SB, United Kingdom, www.witherbyseamanship.com.

NFPA 30, *Flammable and Combustible Liquids*

NFPA 51B, *Cutting and Welding Processes*

NFPA 70, *National Electrical Code*

NFPA 77, *Static Electricity*

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

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1
air supplied respiratory protection
A respirator that provides a supply of safe breathing air from a tank (either a self-contained breathing apparatus portable tank or an air line supply tank) or from a source of fresh air (approved breathing air compressor) not subject to potential contamination.

3.2
atmospheric monitoring equipment
The oxygen monitors, combustible gas indicators, and toxic substance analyzers used to test or sample atmospheric conditions and determine, indicate, measure, and monitor the amount of oxygen and hazardous substances in the atmosphere.

3.2.1
combustible gas indicator
An instrument used to sample the atmosphere and indicate the concentration of vapor/gas present in the atmosphere as a percentage of the lower explosive (flammable) limit.

3.2.2
flammable vapor indicator
See *combustible gas indicator.*

3.2.3
oxygen monitor
A device capable of detecting, monitoring, and measuring the concentration of oxygen in the atmosphere.

3.3
blanking
The absolute closure of a pipe by fastening a solid, flat plate (designed to retain anticipated pressure), between two flanges, using two gaskets and fully engaged bolts or stud bolts in all flange bolt-holes. See ASME B16.47 for additional information.

3.4
blinding
The absolute closure of the open end of a pipe by fastening a solid, flat plate (designed to retain anticipated pressure) across the opening, using a gasket and fully engaged bolts or stud bolts in all flange bolt-holes. See ASME B 16.5 for additional information.

[5] National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169-07471

3.5
bonding
The joining of metal parts to form an electrically conductive path that ensures electrical continuity and has the capacity to safely conduct any current likely to be generated.

3.6
clean
(cleaning)
The removal of all product, vapor, sludge, and residue from a tank and washing, rinsing and drying a tank so that no product or residue remains on any tank surfaces (shell, bottom, sumps, columns, supports, roof, piping, appurtenances, etc.).

3.7
combustible liquid
A liquid having a closed cup flash point equal to or greater than 100 °F (38 °C).

3.8
confined space
Any tank or space that meets *all three* of the following requirements:

— is large enough and so configured that an employee can bodily enter and perform assigned work, and

— has limited or restricted means for entry or exit (for example, tanks and vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry or exit), and

— is not designed for or meant to be continuously occupied by employees.

3.8.1
non-confined space
A space (previously classified as a permit required confined space or a non-permit required confined space) that no longer meets any of the requirements for either a permit required confined space or a non-permit required confined space.

NOTE An example of a non-confined space is a tank that has been cleaned, tested as gas and vapor free, and has a large opening (door sheet) cut into the side of the tank to provide unrestricted access and egress.

3.8.2
non-permit required confined space
A confined space (a space that meets *all three* of the confined space requirements) but has been checked, inspected, and its atmosphere has been monitored and it does not have (or does not have the potential to have) any of the characteristics required to be classified as a permit required confined space.

3.8.3
permit-required confined space
A confined space that has *all three* of the confined space requirements and also has *one or more* of the following five characteristics.

— Contains or has the potential to contain a hazardous atmosphere.

— Contains a material with the potential to engulf an entrant.

— Has an internal configuration such that an entrant could become trapped or asphyxiated by inwardly converging walls or by bottoms that slope downward, tapering to smaller cross-sections.

— Contains any other recognized serious safety or health hazard.

— Has a floating roof not properly prepared and secured in accordance with this standard.

NOTE A tank's floating roof not properly prepared and secured in accordance with this standard (liquid and gas free pontoons and/or compartments, open roof drain and supports/restraints for vertical, horizontal and rotational movement) shall be considered a permit required confined space, even if the tank is otherwise considered a non-confined space.

3.9
degassing
The process of collecting, oxidizing, or treating vapors and gases expelled from a tank or vessel so as to prevent or reduce the amount of organic volatile compounds released into the atmosphere during vapor and gas freeing operations.

3.10
double block and bleed
The positive closure of a pipe by closing and locking or tagging two in-line valves, and by opening and locking or tagging a drain or vent valve in the line or pipe between the two closed valves.

NOTE Employers may evaluate and designate a single valve that uses two sealing surfaces with a drain orifice between them as satisfying double block and bleed requirements.

3.11
electrical division classification of hazardous (classified) locations
The division classification system is used to designate locations where fire or explosion hazards may exist due to the potential for the presence of flammable gases, vapors, or liquids.

NOTE These classifications are identical to those defined by NFPA 70, The *National Electric Code*.

3.11.1
Class I, Division 1
A location wherein any one of the following conditions applies:

— ignitable concentrations of flammable gases or vapors exist under normal operating condition;

— ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage;

— ignitable concentrations of flammable gases or vapors might be released by breakdown or faulty operation of equipment or processes that might cause electrical equipment to simultaneously fail in such a manner as to become a source of ignition.

3.11.2
Group A, B, and C locations
Some petrochemical products require higher levels of protection than Group D, including, but not limited to, acetylene (Group A), hydrogen (Group B), or ethylene (Group C) (see NFPA 70, Article 500, "Hazardous Classified Locations," and NFPA 30, "Flammable and Combustible Liquids," for additional information).

3.11.3
Group D location
A division classified location wherein a specific level of protection is required for flammable and combustible liquid vapor or gas that may burn or explode when mixed with air and exposed to a specific ignition source.

3.12
electrical zone classification of hazardous (classified) locations
The zone classification system is an alternate system to division classification for locations where fire or explosion hazards may exist due to flammable gases, vapors, or liquids.

3.12.1
Class I, Zone 0 location
A location wherein either of the following conditions apply:

— ignitable concentrations of flammable gases or vapors are present continuously;

— ignitable concentrations of flammable gases or vapors are present for long periods of time.

3.12.2
Class I, Zone 1 location
A location wherein any of the following conditions apply:

— ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions;

— ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage;

— equipment is operated or processes conducted in such a manner that breakdown or faulty operations could result in a release of ignitable concentrations of flammable gases or vapors and simultaneously cause failure of equipment so as to create a source of ignition;

— location adjacent to a Class I, Zone 0 location from which ignitable concentrations of flammable gases or vapors could be communicated unless such communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

3.13
emergency
Any occurrence or event (including, but not limited to, failure of hazard control or monitoring equipment) internal or external to a confined space, that could endanger workers or negatively impact on the tank work.

3.14
employer
Owner/operators *and* contractors, whose respective employees are performing a task or activity described in this standard. Where owner/operator *or* contractor is used after “employer(s)”, a specific requirement can be met by either party or both. See *Worker.*

3.14.1
contractor
A company or person selected and hired by the owner/operator to conduct tank cleaning or entry operations and activities in accordance with the contract and tank cleaning agreements. There may be more than one contractor on a job at the same time.

3.14.2
owner/operator
The company or person responsible for the facility in which the tank to be cleaned or entered is located.

3.14.3
sub-contractor
A company or person selected and hired by a contractor to conduct specific tank cleaning or entry related operations and activities in accordance with sub-contract agreements. There may be more than one sub-contractor on a job at the same time.

3.15
empty
A tank that has no appreciable standing product remaining in the tank and is ready for cleaning.

3.16
engulfment
The surrounding and effective entrapment of an entrant by a liquid or finely divided (flow-able) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction or crushing.

3.17
entry
The action by which an entrant passes through an opening into a confined space. Entry includes ensuing work activities in both permit required confined spaces and non-permit confined spaces, and is considered to have occurred as soon as a part of the entrant's body breaks the plane of an opening into the space.

3.18
explosive (flammable) range
The range of concentrations of flammable vapor-in-air, between the lower explosive (flammable) limit and the upper explosive (flammable) limit that will propagate flame if ignited. The explosive range and flammable range are not exactly the same, but for the purposes of this document, they are considered equivalent and used interchangeably.

3.18.1
lower explosive (flammable) limit
LEL
The minimum concentration (expressed as a volume percentage) of a vapor-in-air below which propagation of flame does not occur on contact with an ignition source; generally considered to be "too lean to burn."

3.18.2
upper explosive (flammable) limit
UEL
The maximum concentration (expressed as a volume percentage) of a vapor-in-air above which propagation of flame does not occur upon contact with an ignition source; generally considered "too rich to burn."

3.19
flammable gas
See **flammable vapor**.
A substance that exists exclusively in the gaseous state at normal atmospheric pressure and temperature and is capable of igniting and burning when mixed with air (oxygen) in the proper proportion and subjected to a source of ignition. In this standard, for tank cleaning purposes, *flammable gas* shall be considered the same as *flammable vapor.*

3.20
flammable liquid
A liquid having a closed cup flash point below 100 °F (38 °C).

3.21
flammable vapor
See flammable gas.
The gaseous phase of a substance that is a liquid at normal temperature and pressure and is capable of igniting and burning when mixed with air (oxygen) in the proper proportion and subjected to a source of ignition. Vapors from flammable and combustible liquids are heavier than air.

3.22
flash point
The minimum temperature at which sufficient vapor is given off to form an ignitable mixture with the air near the surface of the liquid, as determined in accordance with NFPA 30, Section 4.4.

3.23
gas freeing
See *vapor freeing.*

3.24
hazardous atmosphere
An atmosphere that has the potential to expose entrants to the risk of death, incapacitation, impairment of ability to self-rescue (escape unaided from a confined space), injury, or acute illness from one or more of the following causes:

— flammable gas, vapor, or mist in excess of 10 % LEL;

— airborne combustible dust at a concentration that meets or exceeds 80 % of its LEL. The LEL may be approximated as a condition in which the dust obscures vision at a distance of 5 ft or less;

— atmospheric oxygen concentration below 19.5 % or above 23.5 %;

— atmospheric concentration of any substance for which a dose or permissible exposure limit (PEL) is published in applicable government regulations, Material Safety Data Sheets, standards or other publications or internal documents, that could result in employee exposure in excess of the substance's dose or PEL;

— any other atmospheric condition immediately dangerous to life or health (IDLH).

3.25
hazardous (substance) material
A substance or material that is capable of harming people, other materials, property, or the environment. These substances may be liquid, solid or gaseous and toxic, corrosive, flammable, reactive, or otherwise hazardous.

3.26
immediately dangerous to life or health
IDLH
Any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an entrant's ability to escape unaided from a confined space. Examples include oxygen deficient atmospheres and the presence of hazardous quantities of hydrogen sulfide and other toxic substances.

3.27
inerting
The displacement of hydrocarbon gas or vapors and oxygen (air) to eliminate the possibility of a flammable atmosphere in a permit required confined space. This is accomplished by using an inert gas that is noncombustible, non-contaminating, and non-reactive (e.g., nitrogen) or a gas containing an insufficient amount of oxygen to support combustion (e.g. flue gas), to such an extent that the resultant atmosphere is noncombustible or nonreactive.

Caution—Use of inert gas or flue gas creates an IDLH oxygen deficient atmosphere.

3.28
isolation
The process by which a tank is completely protected against the release of energy or material into the tank by 1) lockout/tagout; 2) breaking, misalignment of, opening or removing sections of lines or pipes; or 3) disconnecting mechanical linkages.

3.29
lead free tank
A tank that has been certified by the owner/operator as never having been used to store leaded gasoline, lead additives, or products that have contained lead.

Alternately, a tank that has been cleaned according to this standard, tested for lead-in-air and found to have an internal atmosphere below the applicable limit for exposure to organic lead. Entry supervisors shall be aware of applicable regulatory requirements for exposure to lead (such as U.S. DOL OSHA 29 *CFR* 1910.1000). At the time of publication of this standard, the OSHA permissible exposure limit was 2 micrograms of organic lead per cubic foot (0.075 milligrams of organic lead per cubic meter).

3.30
lockout/tagout
The placement of a lockout or tagout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled are not operated until the lockout or tagout device is removed.

Where required by regulation or employer procedures, the system shall be tested to assure isolation.

3.30.1
energy isolating device
A mechanical device that physically prevents the transmission or release of energy. Energy isolating devices include:

— manually operated electrical circuit breakers,

— disconnect switches,

— double block and bleed valve systems,

— blanks and blinds,

— threaded caps and plugs, conduit seals, etc.,

— blocks for mechanical linkages,

— roof drain valves on external floating roof tanks.

Push buttons, selector switches, and other control circuit type devices are not considered energy isolating devices.

3.30.2
energy source
Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy. Examples include: pressure in pipes, electrical equipment and instrumentation, water accumulation on external floating roofs, heating coils, mixers, etc.

3.30.3
lockout device
A device that utilizes a positive means such as a lock (either key or combination type) to hold an energy isolating device in a safe position and prevent the energizing of a machine or equipment. Blanks and blinds are considered lockout devices.

3.30.4
tagout device
A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

3.31
may
Is used in this standard to provide information on procedures and practices that are optional (see “shall” and “should” in the Foreword).

3.32
non-confined space
See **confined space**.

3.33
oxygen deficient atmosphere
An atmosphere containing less than 19.5 % oxygen by volume.

3.34
oxygen enriched atmosphere
An atmosphere containing more than 23.5 % oxygen by volume.

3.35
periodic
The time period established by the employer when atmospheric testing or monitoring is required dependent on the potential hazards and the work being performed.

3.36
permissible exposure limit
PEL
The designated limit of exposure to any airborne contaminant to which an employee may be subjected, expressed as an 8-hour time-weighted average, a ceiling value, a short-term exposure limit or a skin exposure designation. A short term exposure limit (STEL) may be different from the PEL. The PEL is determined by the appropriate regulatory agencies (e.g. OSHA) and employer policies.

3.37
permit program
The employer’s overall program of written procedures for controlling access to a tank work area, including permits for access to confined spaces and protecting entrants from hazards. Based on site specific requirements the procedures and permits required for entry or hot work may extend to safe (cold) work and entry into a specific work area. The written procedures shall include the safety and health requirements for issuance of the permit, conditions for canceling or suspending the permit and safeguarding or returning the space to service following termination of entry.

3.37.1
entry permit
confined space
The written or printed document provided by the employer issued by an entry supervisor that provides the site, potential hazard and work specific information necessary to control and authorize entry into a confined space including conditions canceling the permit and requirements for safeguarding or returning the space to service following termination of entry.

3.37.2
hot work permit
The employer's written authorization to perform hot work operations or use equipment (including, but not limited to, open flames, welding, cutting, grinding, burning, heating, abrasive blasting, use of internal combustion engines and non-explosion proof electric motors) capable of producing a source of ignition. The hot work permit may be part of the entry permit or a separate document. Safe (cold) work is work that is not hot work.

3.38
prohibited condition
Any condition in a permit required confined space that is not allowed by the permit during the period when entry is authorized.

3.39
purging
The process of inerting.

3.40
pyrophoric iron sulfide
A material capable of rapid spontaneous ignition when exposed to air.

3.41
removal from service
The process of removing all possible product from the tank, including inspection and setting of floating roof legs or suspension cables (to the maintenance position) if applicable.

3.42
residue
Undesirable (potentially flammable, toxic, and/or hazardous) material (including but not limited to, rust, dirt, scale, paint scrapings, pyrophoric iron sulfide deposits, etc.), removed from the inside of tanks during the cleaning process (see *sludge)*.

3.43
retrieval system
The equipment (including retrieval lines, chest or full body harness, wristlets, and lifting devices or anchors) used for rescue of persons from confined spaces.

3.44
return to service
The process of returning the tank to its intended operation after all work inside the tank has been completed. This includes:

a) inspecting the inside of the tank to ensure:

— all entrants have exited,

— all temporary equipment has been removed,

— the tank is properly cleaned of debris, tools, etc.,

— all internal appurtenances are connected and functional;

b) reactivating isolated equipment;

c) conducting a hydrotest if required;

d) re-filling the tank with product;

e) inspecting the tank while filling to ensure no leaks;

f) re-setting roof legs or cables to the operational position if applicable;

g) sampling and gauging.

3.45
safety data sheet
SDS
Written or printed material prepared in accordance with applicable regulations and standards concerning hazardous chemicals. SDS's provide physical properties, safety, fire prevention and protection, personal protection, and health data.

3.46
sludge (tank bottoms)
Undesirable materials that accumulate in the bottom of storage tanks and are removed for disposal, usually consisting of heavy petroleum products or a mixture of hydrocarbons, residue, and water that may be flammable, hazardous and/or toxic (see *residue).*

3.47
sour
Petroleum products where sulfur compounds, such as hydrogen sulfide (H_2S) or mercaptans are present in products such as sour crude and heavy residual fuel oils).

3.48
testing
The process by which the potential hazards that may encountered when entering a permit required confined space, a non-permit required confined space or non-confined space are identified and evaluated. Testing includes specifying the type of testing to be performed, the instrument(s) to be used for testing, the classification of the space and the permissible limits for safe entry into the space.

3.49
threshold limit value
TLV
The maximum airborne concentration of hazardous substances to which, it is believed, nearly all workers may be repeatedly exposed day after day without adverse effects, as determined by the appropriate regulatory agencies and employer policies, including, but not limited to, exposure limits developed by the responsible committees of the American Conference of Governmental Industrial Hygienists.

3.50
toxic materials
substances
Any material or substance whose properties are such that they can cause injury to a biological system, depending on exposure concentration, time of exposure, and means of exposure.

3.51
vapor freeing
The removal of flammable or toxic vapors and gases from a tank by displacement or the reduction of the percentage of vapors and gases in the tank to a safe level by dilution with fresh air.

3.52
ventilation
Providing fresh air inside a tank to maintain an atmosphere within acceptable permit limits and provide the required number of air changes per hour. Ventilation occurs after flammable vapors, toxic vapors and gases, dusts, fumes, or mists have been displaced or diluted by vapor and gas freeing (and degassing if applicable).

3.53
work operations
Any work performed on tanks in accordance with this standard.

3.54
worker
A qualified person working in or around a tank during tank cleaning or entry.

3.54.1
attendant
A qualified employee stationed outside one or more permit required confined spaces who monitors the entrants and who performs all attendant's duties in accordance with the employer's confined space program.

3.54.2
bottle watch
A qualified person assigned to control and oversee supplied air operations.

3.54.3
entrant
A qualified person who is authorized by the entry supervisor to enter a confined space.

3.54.4
entry supervisor
The qualified person designated by the employer (owner/operator or contractor) to be responsible for determining acceptable entry conditions at permit required confined spaces and non-permit required confined spaces. Entry supervisors shall authorize entry, oversee entry operations, and terminate entry as required by the permit or conditions. The duties of entry supervisor may be passed from one entry supervisor to another entry supervisor, during the course of an entry operation.

NOTE An API certified Tank Entry Supervisor (TES) is considered qualified to perform the duties of entry supervisor.

3.54.5
qualified person
A person designated by an employer as having the necessary training, education and competence to perform assigned tank work.

3.54.6
rescuers
The personnel designated as part of a written plan to rescue entrants from a confined space. Rescuers shall meet the following requirements.

— Rescuers shall be annually trained in emergency rescue procedures including practice of confined space entries.

— Rescuers shall have the capability to reach the victim(s) within a time frame appropriate for the permit space hazard(s) identified.

4 Administrative Controls and Procedures

4.1 General Requirements

Employers shall develop and implement appropriate administrative controls, procedures and written plans for tank. cleaning/entry projects. These requirements apply to the entirety of tank cleaning/entry projects from planning through return-to-service.

Employers shall inform all workers who may enter a permit-required confined space of the existence and location of and the danger posed by permit-required confined spaces by posting danger signs or any other equally effective means.

Employers shall take effective measures to prevent workers not authorized to enter permit-required confined spaces from entering permit-required confined space.

4.2 Written Tank Cleaning/Entry Programs

Written tank cleaning/entry programs shall address:

— each applicable tank pre-cleaning/entry, cleaning/entry, and post-cleaning/entry element listed in 4.6.2, 4.6.3, and 4.6.4;

— applicable requirements of Section 5 through Section 14 of this standard.

4.3 Written Tank-specific Cleaning/Entry Plans

4.3.1 General

Before a tank is opened and before workers enter a tank for any reason, employers shall develop written tank-specific work plans that shall be discussed and understood by all affected parties in a tank pre-cleaning/entry meeting. These plans shall include the following.

4.3.2 Scope of Work

The scope of work shall include identification of, and requirements for the:

a) specific tank(s) to be cleaned and/or entered;

b) tank construction and condition of the tank(s);

c) products contained;

d) specific work to be done;

e) roles and responsibilities of employers and workers;

f) schedule of each phase of the work;

g) programs identified under 4.2 that are applicable to the specific tank project.

The scope of work may change throughout the course of a tank project and written work plans shall be modified to reflect significant changes to the scope of work.

4.3.3 Tank Pre-cleaning/Entry Meetings

A meeting and site survey shall be conducted for all tanks to be entered or cleaned. This meeting shall include discussion of or with:

— all parties that could potentially enter the tank or whose activities could affect tank entry operations;

— tank removal from service;

— job-specific vapor/gas freeing, degassing, and ventilation requirements;

— the scope of work and specific roles and responsibilities of all parties that could affect the project;

— job-specific requirements for tank entry;

— job-specific lockout/tagout requirements, isolation devices, and energy sources;

— anticipated site and tank entry hazards.

4.3.4 Subsequent Meetings

Subsequent meetings may be required to address changes in conditions or significant changes in work scope, including:

— safety issues;

— different phases of a tank project (cleaning, repairs, coatings, etc.);

— different contractors associated with different project phases;

— scope of work changes;

— changes in identified hazards;

— changes in entry requirements.

4.4 Regulatory Requirements

In addition to the requirements contained in this standard, employers shall refer to applicable federal, state and local government regulations pertinent to specific tank cleaning activities, including regulations of governments other than those of the United States, when appropriate.

This standard is intended to be consistent with Title 29 of the *U.S. Code of Federal Regulations, Occupational Safety and Health Administration Standards,* Part 1910, "Occupational Safety and Health Standards," and Part 1926, "Safety and Health Regulations for Construction."

This standard is intended to be consistent with appropriate National Fire Protection Association Codes and Standards applicable to the entry and cleaning of aboveground petroleum storage tanks.

If any provision of this standard conflicts with statutory or regulatory requirements, said statutes and regulations shall govern. This standard is not intended to be a substitute for regulations, codes, standards, or employer safe (cold) and hot work practices and procedures, all of which must be reviewed in their entirety to determine applicability to the facility, and the location, the tanks involved, and the proposed work.

4.5 Tank Cleaning/Entry Overview

4.5.1 General

The following outline summarizes the steps involved in the process of emptying and cleaning a tank, making it safe for entry to perform any inspection and repairs and, finally, returning the tank to service.

a) Performing a task safely is of the utmost importance. Tasks should not be attempted unless the hazards have been properly assessed and the tasks can be completed in a safe manner. Inspection may be required to determine that the hazards have been properly addressed.

b) There are a number of basic activities applicable to every tank that is to be cleaned or entered. These activities include, but are not limited to:

   — confined space classification;

   — hazard evaluation and atmospheric testing;

   — isolation and removal from service (see Note 1);

   — inspection (for safety);

   — vapor/gas freeing and ventilation (see Note 1);

   — tank entry;

   — product sludge and residue removal and disposal (see Note 1);

   — hot and safe (cold) work operations;

   — return to service (see Note 2).

   NOTE 1 Only required for those tanks that are being cleaned.

   NOTE 2 In some cases, a tank may not be returned to service.

Other common activities not necessarily applicable to every tank include, but are not limited to:

— regulatory permitting and notifications,

— degassing,

— setting floating roof legs or cables,

— stabilizing floating roofs.

c) Many of these activities are covered by existing employer programs and procedures such as Confined Space; Energy Isolation (Lockout/Tagout); Hot Work and Safe Work; Hazard Communications; Operations, Maintenance, and Inspection; Respiratory Protection and Process Safety Hazard Analysis.

4.5.2 Tank Pre-cleaning/Entry Elements

These elements include establishing procedures for the following.

a) Qualifying and selecting tank cleaning contractor(s) and sub-contractors.

b) Training and qualifying workers for assigned tasks; including tank cleaning supervisors, entrants, testers, attendants, bottle watches, rescuers, and other workers for tasks such as hazard evaluation, testing, permit issuance, entry, tank cleaning, attendant, rescue, and inspection activities.

c) Evaluating potential safety, fire, and health hazards of product, sludge, and residue in the tank and the hazardous chemicals used to clean or repair the tank.

d) Establishing, exposure limits and procedures for atmospheric testing and determining, achieving, and maintaining safe exposure levels for oxygen, flammable vapors, and toxic materials such as hydrogen sulfide, benzene, and organic lead.

e) Notifying and obtaining permits from regulators.

f) Determining tank- and area-specific physical hazards.

g) Determining that the tank's structural condition and physical integrity are satisfactory to safely perform the planned work.

h) Identifying confined spaces, classification programs and procedures, and classifying tanks to be cleaned (and floating roofs to be entered) as permit required confined spaces, non-permit required confined spaces or non-confined spaces.

i) Developing a hot work, safe (cold) work, and entry permit program and system to establish requirements and responsibilities for permit issuance and cancellation.

j) Determining personal and respiratory protection requirements.

k) Assigning specific work to be performed and responsibilities.

l) Conducting a tank pre-cleaning/entry meeting and site survey with all parties involved.

4.5.3 Tank Cleaning/Entry Elements

These elements include establishing procedures for the following.

a) Entry onto floating roofs, inspecting roofs for stability, and inspecting and setting legs or suspension cables.

b) Floating roof stabilization to protect personnel under the floating roof from roof collapse.

c) Removal of recoverable product and removal, handling, storage, and disposal of sludge and residue (hazardous waste).

d) Selecting the required tank cleaning equipment.

e) Controlling potential ignition sources in the area including hot work, sparking (e.g. inadequate grounding and bonding), electrically driven equipment, internal combustion engines, lighting, and communication devices.

f) Equipment operation such as vacuum trucks, pumps, eductors/blowers, degassing equipment, and tank cleaning equipment.

g) Normal and emergency communication and notification procedures.

h) Implementing an emergency response and rescue plan; designating rescuers; and determining required rescue equipment.

i) Tank isolation; including valves, connections, lines, drains, water draws, impellers, agitators, heating coils, mechanical and electrical appurtenances, etc.

j) Vapor/gas freeing, and if required, degassing and inerting.

k) Continuous or periodic flammable vapor and toxic exposure monitoring and continued mechanical ventilation during entry and work.

l) Heat and cold exposure of employees in and around the tank, including consideration of work schedules and rest periods.

m) Cleaning, inspection, and testing procedures to assure the tank, double walls and bottoms, roofs, internal lines, pontoons, floating roof supports, columns, sumps, etc. are completely free of liquid, vapors, gases, and contaminants (including acids or chemicals used in treating or cleaning tanks) after cleaning.

n) Assuring that any tank that is classified as either a permit required or a non-permit required confined space is not left open and unattended.

o) Work and entry permit requirements for owner/operator and contractor/sub-contractor employees working inside and around the tank, including requirements for personal protective equipment and respiratory (breathing air) protection.

p) Re-classification of a cleaned and open tank as a non-permit required confined space or a non-confined space, provided all requirements for the classification are satisfied.

q) Safe (cold) work and hot work operations inside, and around a tank depending on whether the tank is open or closed, cleaned or not cleaned, and classified as a confined space or a non-confined space.

r) Conducting subsequent meetings with involved parties to address changes in conditions or significant changes to the scope of work.

4.5.4 Tank Post-Cleaning/Entry Elements

These elements include establishing procedures for the following.

a) Returning tanks to service; including inspections and safety checks to assure that the tank is clean and free of waste and debris.

b) Checking the tank and lines during refilling for leaks and to prevent overfilling the tank.

c) Entry onto tank roofs following refilling.

d) Assuring that all required reports, documentation, and records are completed, maintained on file and filed with the proper authorities as required.

e) Conducting a post-tank cleaning/entry review and adjusting procedures as necessary.

4.6 API Recommended Practice 2016

API Recommended Practice 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks,* provides guidance and supplemental information that may assist employers in developing plans and conducting safe tank cleaning operations in accordance with the requirements of this standard.

This includes specific aspects of:

— storage tank hazards (oxygen deficiency/ enrichment, fires/explosions, toxic substances, stress exposures and physical hazards);

— vapor/gas freeing, degassing, and ventilating;

— sludge and residue removal;

— unique tanks (>200 ft diameter, double bottoms/walls, low pressure tanks and conservation tanks);

— iron sulfide, hydrogen sulfide, lead and hazardous waste;

— control of ignition sources;

— air monitoring equipment;

— floating roof hazards.

5 Preparing the Tank for Entry and Cleaning

5.1 Initial Preparation

Sections 5.1.1 through 5.1.7 should be performed prior to tank cleaning/entry operations.

5.1.1 Employers shall review available up-to date drawings and sketches of the external and internal tank configuration, piping and valves, supports, floating roof design, appurtenances, and the site layout. Plans shall be developed to mitigate or control the potential physical hazards expected before and during the tank cleaning/entry operation.

5.1.2 Employers shall obtain and review applicable SDSs or equivalent information concerning the products presently and historically contained in the tank to be cleaned, the products presently contained in adjacent tanks in

the same dike area and any hazardous materials to be used to clean the tank. Employers shall determine the potential hazards associated with these products, sludge, residue, and materials and develop vapor and gas freeing, ventilation, and (where required) degassing, mitigation and control methods, and personal protection requirements. SDSs and other information regarding potential hazardous exposures from products and materials shall be available at the work site for worker review.

5.1.3 Employers shall identify and classify such tanks as permit required confined spaces, non-permit required confined spaces or non-confined spaces depending upon the condition of the tank at any time during the tank cleaning/entry process.

5.1.4 Employers shall establish criteria for classifying entry upon a floating roof (where applicable) as permit required or non-permit required confined space entry or as non-confined space entry.

NOTE It is petroleum industry practice to normally consider entry upon an open-top floating roof that is within 5 ft of the top of the tank to be non-confined space entry provided that: (1) no physical hazards are present; and (2) testing has been conducted to assure that no hazardous flammable or toxic atmospheric is present on the roof top.

5.1.5 Employers shall ensure that confined-space entry plans are made available to all workers and that workers are properly trained prior to assignment to any confined space work.

5.1.6 Employers shall assure that procedures and work plans provide sufficient information for workers to anticipate, recognize, test, analyze, and determine appropriate measures to control potential hazards that may be encountered during tank cleaning/entry operations.

5.1.7 Owners/operators shall establish criteria for the operation of adjacent tanks within the same dike area as the tank being cleaned (or within 100 ft of the tank being cleaned if outside the dike area) to control vapor emissions from these tanks.

5.2 Removal From Service

5.2.1 Setting Floating Roof Legs or Suspension Cables

The following shall be performed while the floating roof is floating and it can be done safely.

— The floating roof legs or suspension cables shall be properly adjusted at the same height (preferably in the high position) to allow room for entrants to work underneath the roof after the tank is emptied.

— The floating roof legs or suspension cables (including attachment to the cone roof) shall be visually inspected where possible or otherwise evaluated for damage or deterioration and any unsafe condition reported to the Entry Supervisor prior to landing the floating roof.

— If applicable, floating roof compartments shall be inspected to ensure that they are empty. Pontoons that are not empty shall be reported to the entry supervisor prior to landing the floating roof.

— The floating roof shall be visually inspected for damage. Potentially unsafe damage shall be reported to the entry supervisor prior to landing the floating roof.

5.2.2 Product Removal

The tank shall first be emptied of all product through the tank discharge nozzle, sample line, water draw-off, or other suitable fixed connections without opening the tank openings (e.g. manways).

Product, sludge, and residue that remains below the tank discharge nozzle or other fixed connections shall be removed from the tank using procedures established by the employer for the specific tank cleaning operation.

5.3 Isolating The Tank

5.3.1 Isolating Lines

The tank shall be isolated from all connected lines including, but not limited to, product, vapor, relief, gauging and sampling, and water draw-off lines (see exception for foam lines, below). Lines shall be isolated as close to the tank as practicable by:

— installing blanks between two flanges, using two gaskets and fully engaged bolts or stud bolts in all flange bolt-holes; and/or

— using double block and bleed valve systems with lockout/tagout devices;

— disconnecting lines from the tank and installing blinds across the opening, using a gasket and fully engaged bolts or stud bolts in all flange bolt-holes.

Blinds and blanks shall completely cover the bore and be capable of withstanding the anticipated chemical exposures and maximum pressure of the line with no leakage beyond the gasket, blind, or blank.

A qualified person shall inspect the blinds and blanks prior to use, to assure that they are installed properly and in good condition with no cracks, pits, holes, or other deterioration.

5.3.2 Isolating Energy Sources

Entry supervisors shall confirm that the following is performed.

— All energy sources shall be isolated (including, but not limited to, electrical, steam, hydraulic, and mechanical).

— All tank equipment and appurtenances (including, but not limited to, tank mixers, heaters, sensors, and other instrumentation) shall be isolated by disconnecting, and installing blinds, blanks, and/or double block and bleed valve systems.

— A qualified person shall inspect and test gauging and instrumentation equipment to assure that no liquid product, hydrocarbon vapor, toxic material, or toxic atmosphere is present within the system.

— Isolation devices shall be locked/tagged out and tested (where required or appropriate) before beginning tank cleaning operations.

5.3.3 Foam Lines

If the tank has a fixed or semi-fixed fire protection foam system, a qualified person shall inspect and test the foam lines to assure that no liquid product, hydrocarbon vapor, toxic material, or toxic atmosphere is present within the system. Foam lines may remain connected throughout the tank cleaning operation for use against a fire within the tank.

5.3.4 Cathodic Protection

If a tank or lines have cathodic protection, the employer shall assure that whenever a tank valve or line is to be disconnected, safe isolation practices are followed, in the order shown.

1) Turn off the cathodic protection system.

2) Install a bond wire from the tank to the lines.

3) Disconnect and remove the valve or line.

4) Remove the bond wire only after the valve or line is disconnected.

5.4 Control of Ignition Sources

5.4.1 General

Entry supervisors shall assure that all ignition sources in the area are eliminated or controlled before permitting any work to be conducted that might involve the potential release of flammable vapors into the atmosphere around or inside the tank.

5.4.2 Motorized (Internal Combustion) Equipment

Before issuing entry or work permits, entry supervisors shall require that internal combustion powered equipment (including, automobiles, trucks, vacuum trucks, forklifts, pumps, welding machines, and compressors) are restricted to designated safe areas (such as outside the tank dike area) away from sources of flammable vapors, by notation on the permits and, if necessary, by posting signs and/or barricading access to the area. Entry supervisors shall be aware that the use of diesel powered internal combustion equipment is preferred to using gasoline or gas powered equipment.

5.4.3 Electrical Tank Equipment

Entry supervisors shall assure that all electrical equipment and appurtenances that may be a source of ignition, and that are in, attached to and around the tank, are disconnected and locked or tagged out before issuing an entry permit. Such equipment and appurtenances include, metering devices, alarms, sensors, overflow protection systems, cathodic protection systems, and electrical heating coils.

5.4.4 Electrical Tank Cleaning and Maintenance Equipment

Depending on the potential exposures, entry supervisors shall assure that all electrically powered tank cleaning and related equipment, electrical powered tools, communication devices, lights, and motors, used throughout tank cleaning operations, meets the minimum requirements of NFPA 70 for Class I, Division 1, Group D (or higher) (or Class 1, Zone 0 or Zone 1) locations. The use of any type of non-explosion proof electrical equipment shall be prohibited unless specifically permitted under an authorized job site procedure or entry, hot work or safe (cold) work permit.

5.4.5 Electrical Bonding and Grounding (Earthing)

5.4.5.1 Bonding and grounding cables and clamps shall be inspected by a qualified person to assure good condition, adequacy, and integrity prior to the start of work and periodically, as necessary, during the work. Entry supervisors shall assure that equipment capable of creating an ignitable spark upon disconnection is properly bonded and grounded (earthed) before issuing permits. Entry supervisors shall assure that bonding and grounding procedures include the following requirements.

5.4.5.1.1 All metallic parts of vacuum hoses, suction hoses, vacuum trucks, and pumping equipment shall be bonded to the tank.

5.4.5.1.2 All metallic parts of vapor and gas freeing, degassing and ventilating equipment, including blowers, educators, and ducting (wire helix) shall be bonded to the tank.

5.4.5.1.3 Nozzles of steam, water, solvent and chemical hoses shall be bonded to the tank.

5.4.5.1.4 Static generating equipment, including, but not limited to, vacuum trucks, compressors, and pumps, shall be bonded to the tank and properly grounded (earthed).

5.4.5.1.5 Conductive connectors and conductive hoses used for product and sludge transfer and solvent and chemical washing, shall be bonded to the tank and the receiving (or dispensing) container or truck (see API 2219 for additional information).

5.4.5.1.6 All portable electrical equipment shall be grounded (earthed) by using an approved ground fault circuit interrupter (GFCI) or other approved means of grounding (earthing). A qualified person shall assure that the capacity and continuity of the GFCI adequately protect workers.

5.4.5.1.7 Welding machines shall be grounded (earthed) and bonded to the tank or other equipment or structure being welded. A qualified person shall assure that the capacity and continuity of the grounding and bonding are adequate to protect workers.

5.4.6 Ignition Sources from Compressed Air

Employers shall require and entry supervisors shall assure that air compressors are equipped with appropriate filters to remove moisture, scale, rust, oil and other contaminants from the compressed air, as moisture and particles in the air stream can generate static electricity and become a source of ignition. Entry supervisors shall assure that any compressors used to provide fresh air (non-breathing air) into a tank for vapor and gas freeing, degassing and ventilation are grounded (earthed) and bonded to the tank.

5.4.7 Lightning and Thunderstorms

5.4.7.1 Whenever an electrical storm is threatening or in progress in the area of a facility where tank cleaning and/or entry activities are being conducted, entry supervisors shall require the following actions to be taken.

5.4.7.1.1 The entry and work permits shall be cancelled.

5.4.7.1.2 All work inside and outside the tank shall cease and entrants shall leave the tank.

5.4.7.1.3 All activity with the potential to release vapors into the air, including, but not limited to, vapor and gas freeing, degassing, ventilation, vapor recovery, product transfer, sludge and residue removal, and vacuum truck operations shall stop.

5.4.7.1.4 All openings into the tank shall be closed, sealed, or otherwise protected, if necessary, to prevent release of flammable vapors into the air.

5.4.7.1.5 Entrants, attendants, bottle watches, and tank cleaning workers shall leave the immediate area around the tank and move to a designated safe location.

5.4.8 Pyrophoric Iron Sulfide Deposits

Entry supervisors shall assure that procedures are in place and adequate precautions are required and taken to prevent pyrophoric iron sulfide deposits (often found in tanks containing sour crude petroleum or petroleum products containing hydrogen sulfide) from becoming an ignition source.

5.5 Vapor and Gas Freeing, Degassing, and Ventilating

5.5.1 General

Employers shall establish requirements and entry supervisors shall implement safe procedures for vapor and gas freeing, degassing and ventilating tanks applicable to working around the outside of the tank, opening the tank, testing the tank's atmosphere, inspecting the tank, entering the tank, and cleaning the tank.

5.5.2 Vapor and Gas Freeing Methods

Entry supervisors shall assure that the tank's atmosphere is freed of flammable and hazardous gas and vapors by using approved and appropriate methods that will safely displace or dilute the vapors and gas in the tank, including, but not limited to, the following:

1) vapor and gas freeing by the use of mechanical or natural ventilation;

2) displacing vapors and gas by purging the tank with inert gas, flue gas or steam;

3) displacing the vapors or gas with water or fuel oil;

4) degassing (where required) by the use of thermal oxidation, vapor recovery, carbon absorption or other approved methods.

5.5.3 Vapor and Gas Freeing Selection

Employers shall be aware of the requirements and shall select specific methods for vapor and gas freeing and degassing the tank dependent upon, the following factors:

1) the nature of the vapors or gases involved;

2) degassing and emission control requirements;

3) the potential hazards of the vapor or gas;

4) the area and the type, size, construction, and location of the tank.

5.5.4 Tank Location

Entry supervisors shall be aware that when tanks are located below the surrounding ground level, there is a potential for contaminated air from nearby internal combustion engine exhausts, vacuum truck exhausts or flammable or toxic vapors that have collected in low lying areas, to be drawn into tanks during vapor and gas freeing, degassing and ventilation operations. Entry supervisors shall identify such situations, establish safe work procedures and develop and implement preventative measures to assure fresh air is introduced into the tank.

5.5.5 Environmental Factors

During the tank pre-cleaning phase of the operation, and prior to the start of vapor and gas freeing and degassing, employers shall review applicable environmental regulations to determine if there are requirements to reduce atmospheric vapor emissions through degassing. If degassing is required, entry supervisors shall establish and implement appropriate control measures

5.6 Initial Tank Cleaning

Employers shall determine the potential hazards and exposures and the required flammable and toxic vapor and gas concentration levels at which workers may safely begin cleaning the tank from outside the tank opening (manway). Entry supervisors shall designate the appropriate personal protective clothing and equipment to be used by workers (without entering the tank) and issue appropriate safe (cold) work permits. Entry supervisors shall issue an entry permit if the initial cleaning process requires that tank cleaning workers' hands and arms break the plane of the tank opening (manhole), because this is considered entry into a tank.

6 Testing the Tank Atmosphere

6.1 Atmospheric Testing Procedures

Prior to the initiation of tank work, the employer shall establish written procedures and requirements for testing the atmosphere around the outside of the tank and inside the tank. Atmospheric testing procedures and requirements shall be addressed in work and entry permits.

6.2 Atmospheric Testing Instruments

6.2.1 General

All testing equipment shall be intrinsically safe or approved for use in either Zone 0, Zone 1 or Class I, Division 1, Group D (or greater) locations (see Section 7 of this standard for additional requirements).

6.2.2 Testing Equipment

6.2.2.1 Qualified persons shall only use instruments approved for use by their employer.

6.2.2.2 The manufacturer recommendations and procedures shall be followed, including instrument use and limitations, calibration, bump-testing, maintenance, and repair.

6.2.2.3 The type and amount of exposure to contaminants and the history of need for re-calibration shall be considered when determining the calibration criteria for specific instruments under specific working conditions.

6.2.2.4 The employer shall maintain verification of instrument calibration on record for at least 1 year (or the period of time required by applicable regulations or designated in the employer's confined space program, if longer).

6.3 Atmosphere Testing

6.3.1 Testing Sequence

Initial and subsequent tests around and inside the tank shall be conducted in the following order: (1) oxygen content; (2) flammable vapors; and (3) toxic exposures.

6.3.2 General

6.3.2.1 Entry supervisors shall require that oxygen, flammable vapors and toxic hazard exposures be tested by a qualified person prior to permitting work inside or around the outside of tanks (including tanks that have been previously vapor and gas freed, degassed, ventilated and cleaned, but have remained inactive and closed since the time of cleaning). A qualified person, shall measure the atmospheric concentrations of oxygen, flammable vapors, and toxic materials inside and around the outside of the tank.

6.3.2.2 Testing shall be performed using properly calibrated instruments.

6.3.2.3 A qualified person shall perform testing as frequently as necessary to maintain safe working conditions.

6.3.2.4 Entry permits shall reference SDSs or equivalent information pertinent to determination of atmospheric testing requirements.

6.3.2.5 A qualified person shall determine the safe exposure limits applicable to the proposed entry or work.

6.3.2.6 A qualified person shall determine the need to use specialized toxic substance, or other hazardous substance testing or monitoring instruments in addition to oxygen and flammable vapor instruments.

6.3.2.7 Qualified persons who use testing instruments shall be trained in, knowledgeable of, and follow the requirements given in 6.2.

6.3.3 Testing Requirements

6.3.3.1 A qualified person shall determine the extent of atmospheric tests required and when to conduct initial testing and subsequent testing. Such determinations shall be based on a number of factors, including the following.

6.3.3.1.1 The liquids (including additives) that have been contained in the tank since it was last cleaned (and in the case of leaded products, the entire service history, unless certified lead-free) and the materials used to vapor free and clean the tank.

6.3.3.1.2 The environmental, operational, and other external factors that may potentially affect the atmosphere and inside and around the outside of the tank.

6.3.3.1.3 The tank's configuration and condition, the ability to vapor free, degas and ventilate the tank and the work to be performed.

6.3.4 Testing the Atmosphere Outside the Tank

6.3.4.1 Entry supervisors shall require that a qualified person test and monitor the atmosphere around the outside of the tank, continuously or periodically as required to ensure that atmospheric conditions are within acceptable or permissible levels.

6.3.4.2 Entry supervisors shall assure that vapor and gas freeing, degassing, and ventilation equipment is in place and operating during these tests.

6.3.4.3 Tests shall be taken by a qualified person in the areas around the tank where vapors could collect.

6.3.4.4 Based on the results of the testing, the entry supervisor shall determine the potential hazards and permit requirements so that work around the outside of the tank can be conducted safely.

6.3.5 Testing the Atmosphere Inside the Tank

6.3.5.1 Entry supervisors shall require that a qualified person test and monitor the atmosphere inside the tank after vapor and gas freeing and degassing and during ventilation, to ensure that oxygen levels are satisfactory and flammable and toxic vapors are not present above acceptable or permissible levels.

Where entry is to be made into an OSHA permit-required confined space, workers (or their authorized representatives) shall have the opportunity to observe the pre-entry and subsequent testing.

6.3.5.2 Based on the results of the testing, entry supervisors shall determine the potential hazards and permit requirements so that tank cleaning work and other activities can be conducted safely inside the tank.

6.3.5.3 Entry supervisors shall require that vapor and gas freeing, degassing, and ventilating equipment is shut down for at least 15 minutes prior to testing inside the tank (based on industry experience for 150 ft diameter tanks) to allow the atmosphere inside the tank to reach equilibrium conditions. Entry supervisors shall determine the time required for the atmosphere in larger size tanks to stabilize.

6.3.5.4 The qualified person performing the tests shall wear appropriate protective clothing and air supplied or self-contained breathing apparatus (SCBA), positive-pressure, full face-piece, respiratory protective equipment, and a harness/ lifeline, when entering the tank to conduct testing to establish entry conditions.

6.3.5.5 Prior to permitting vertical entry into a tank (entry from the top of the tank), a qualified person shall test the internal atmosphere at 4 ft (1.2 m) verticals intervals (from top to bottom) to assure that flammable and toxic vapors have not stratified within the tank. This testing shall be done without entry if possible.

6.3.5.6 The qualified person who performs the tests shall ensure that the results represent the true condition of the inside of the tank, so that a proper decision can be made by the entry supervisor regarding safe entry or work inside the tank. A qualified person shall determine if there is a need to test the atmosphere at various elevations or levels inside the tank to establish that permissible entry conditions exist throughout the tank.

6.3.6 Monitoring the Tank's Atmosphere During Entry

Entry supervisors shall require that atmospheric testing or monitoring for oxygen levels, flammable vapors and toxic exposures be conducted periodically or continuously, as necessary, while workers are inside and/or around the outside of the tank, to ensure that desired atmospheric conditions are maintained in accordance with the entry permit, safe (cold) work and hot work requirements.

6.3.7 Documentation

The results of all atmospheric testing, the time of the testing and the signature of the qualified person who performed the tests shall be recorded on (or attached to) the entry permit and shall be available for review by workers (or their authorized representatives).

7 Storage Tank Hazards

7.1 General

7.1.1 Hazards

Entry supervisors shall be aware of and consider the following hazards, including the specific information contained in this section:

a) oxygen deficiency or enrichment,

b) fires and explosions,

c) toxic substance exposures,

d) physical and other hazards.

7.1.2 Testing

Before workers enter a tank at the beginning of each workday or shift, the entry supervisor shall assure that tank's atmosphere is tested and evaluated by a qualified person for oxygen, flammable vapors and toxic exposures and inspected for physical and other hazards. The entry supervisor shall issue entry permits only if all entry requirements are met. When reentering a tank following an evacuation or a break in entry causing cancellation of the permit, the tank's atmosphere shall be re-tested and re-evaluated by a qualified person to determine that conditions have not changed and entry requirements are still being met. The entry supervisor shall then issue a new permit or reissue the existing entry permit, before entrants are permitted to reenter.

7.2 Oxygen Deficiency and Enrichment

7.2.1 General

Before entrants (qualified persons) initially enter any tank including a clean tank that has been closed and inactive; or an empty tank; the entry supervisor shall assure that a qualified person tests the atmosphere for oxygen content.

Following testing and evaluation of test results, the entry supervisor shall issue an entry permit only if conditions are met. While entrants are in the tank, periodic or continuous oxygen monitoring shall be conducted, as necessary, to ensure that the oxygen content in the atmosphere does not change (increase or decrease) from that required by the permit. If a pertinent change in oxygen content occurs, work shall stop and all entrants shall immediately vacate the tank until a qualified person has determined the cause of the change, conditions are evaluated and corrected and the entry permit is reissued.

7.2.2 Oxygen Deficiency

7.2.2.1 A tank may be oxygen deficient for a number of reasons, including the following.

7.2.2.2 Flammable or toxic vapors, steam, water mist or inert gases are still present in the tank, which could occur if the tank has not been properly vapor and gas-freed/degassed and ventilated.

Warning—A tank that has been purged with inert gas or flue gas will be almost devoid of oxygen. If a tank has been maintained under an inert atmosphere, extreme caution must be exercised since the tank may be in an IDLH (immediately dangerous to life and health) condition.

7.2.2.3 Product or vapors may have entered the tank from a variety of sources, including:

— vapors from sludge;

— vapors from deposits and residue on tank walls, bottoms and roofs;

— liquids under the tank bottom and in supports, lines and pontoons.

The vapors of most hydrocarbons stored are heavier than air and will displace or dilute air (oxygen).

7.2.2.4 Oxidation (rusting) may have depleted the tank's oxygen content, especially if the tank has been closed for an extended period of time, even if previously cleaned.

7.2.2.5 Oxygen may be displaced through combustion by welding, cutting, or other hot work.

7.2.2.6 Evaporation of solvents used in paint, linings or coatings.

7.2.3 Oxygen Enrichment

7.2.3.1 Oxygen enrichment increases the explosive (flammable) range of hydrocarbon vapors, effectively reducing the lower explosive (flammable) limit and creating a dangerous potential for a fire to occur should a source of ignition be present. An oxygen enriched atmosphere in a tank (oxygen content over 23.5 %) should not normally occur during the cleaning of stationary storage tanks that have contained petroleum or petroleum products unless there are unusual or extraordinary circumstances. Upon any instance of oxygen enrichment that occurs within a tank, above that of the ambient air external to the tank, the following actions shall be taken.

7.2.3.2 The entry supervisor shall immediately stop operations, entrants shall leave the tank and the entry permit shall be cancelled. The entry supervisor shall identify and control all sources of ignition in the tank area.

7.2.3.3 A qualified person shall investigate the cause of the oxygen enrichment (for example, oxygen bottles or cylinders used during welding or cutting may leak and provide a source of oxygen enrichment).

7.2.3.4 A qualified person shall determine and implement the corrective action required to eliminate or control the oxygen enrichment.

7.2.3.5 qualified person shall conduct atmospheric testing in the tank to assure the conditions are within acceptable limits before the entry supervisor reissues the permit or issues a new permit to allow entrants to re-enter the tank and resume work.

7.3 Fire and Explosion Hazards

7.3.1 General

7.3.1.1 Fires and explosions occur when a source of ignition is introduced into an atmosphere where mixtures of flammable vapor and air are within the explosive (flammable) range. The potential for a fire inside or outside a tank exists during all phases of tank work but the potential is particularly high during vapor and gas freeing and degassing.

7.3.1.2 During tank work, qualified persons shall control vapor exhaust and ignition sources in the vicinity of the tank to prevent possible ignition of flammable vapors.

7.3.1.3 Entry supervisors shall determine that the flammable vapor-in-air levels required for entry into the tank to perform specific operations are within acceptable limits, before any entry permits are issued.

7.3.2 Testing

The entry supervisor shall assure that a qualified person periodically or continuously (as required by the permit) tests and monitors the atmosphere in and around the tank for flammable vapors, especially when vapor and gas freeing, degassing and ventilating is being conducted.

7.3.3 Fires and Explosions

A source of ignition inside or near a tank may result in either a fire or an explosion depending upon a number of factors, including, but not limited to, the following:

1) tank design, construction, condition and integrity;

2) product(s) that have been stored in the tank;

3) inadequate cleaning or ventilation;

4) chemicals used to clean the tank;

5) application of paint, linings or coatings;

6) the location of open vents, relief devices and other tank openings.

7.4 Toxic Substances

7.4.1 General

7.4.1.1 Toxic substances can cause irritation, injury and immediate or delayed illness or death depending upon the characteristics of the substances, the concentration of the substances and the duration of exposure. Entry supervisors shall ensure that workers are aware of the potential routes of toxic exposure (inhalation, skin or eye

absorption, injection, or ingestion), depending upon the characteristics of the substance and the nature of the exposure.

7.4.1.2 Information about the materials contained in the tank, including applicable SDSs, shall be obtained and reviewed by a qualified person during the planning phase of the work to determine the potential toxic hazards and safe exposure requirements. This information shall be available to all workers at the tank work site

7.4.1.3 A qualified person shall review regulatory requirements applicable to the potential toxic exposures to ensure protection and entry requirements are compliant with the OSHA Hazard Communication (HAZCOM) Standard and/or local regulations.

7.4.1.4 Entry supervisors shall determine that exposure levels are within acceptable limits for entry and the appropriate protective clothing, equipment and respiratory protection required for entrants are provided, before an entry permit is issued.

7.4.2 Hydrogen Sulfide

7.4.2.1 Hydrogen Sulfide (H_2S) is a highly toxic, colorless, flammable gas that is dangerous even in low concentrations. It can be said to have a rotten egg smell.

Warning—Sense of smell must never be used as a means to detect the presence of hydrogen sulfide. At higher concentrations it can be fatal. Since higher concentrations deaden the sense of smell, relying on the human nose can often have catastrophic results.

7.4.2.2 Employers shall require precautions, procedures, and controls for prevention of exposure to hydrogen sulfide gas.

7.4.2.3 Use of appropriate respiratory protection is required when the hazard assessment determines that significant exposure is likely.

7.4.3 Organic Lead

7.4.3.1 Highly toxic organic lead compounds such as tetraethyl lead (TEL) and tetramethyl lead (TML) are typically present in tanks that contained leaded gasoline and other leaded products and additives. Exposure to organic lead is highly toxic and can occur at any time until the tank is thoroughly cleaned, dried, tested, and declared to be lead-in-air free.

7.4.3.2 Entry supervisors shall classify tanks that contain or may have previously contained leaded gasoline, leaded compounds, and additives or other petroleum products containing lead, as permit required confined space entry until the tanks have been vapor and gas freed (degassed); ventilated; properly cleaned, dried, and tested; evaluated; and declared lead-in-air free by a qualified person.

7.4.3.3 Entry supervisors and testers shall be aware that there are no instruments that will detect or determine if the tank is or has been in organic leaded service, prior to cleaning and drying. If tests are performed before or during vapor and gas freeing, degassing or cleaning, or while there is liquid or moisture in the tank, the results will be erroneous and misleading.

7.4.3.4 Entry supervisors shall assure that entry permits require the use of appropriate lead hazard personal protection including air supplied or self-contained breathing apparatus, impervious clothing and protective equipment for entry into these tanks.

7.4.3.5 Entry supervisors shall assure that applicable regulatory requirements and facility procedures for control of exposures to organic lead and lead containing product, sludge and residue during handling, removal and disposal are followed during tank cleaning operations.

7.4.3.6 Employers shall establish and implement procedures for decontamination and disposal of contaminated clothing and materials and provide workers with appropriate facilities for washing and changing clothes.

7.4.3.7 Employers shall establish and implement procedures for testing and disposal of product, sludge, deposits and residue that contain organic lead.

7.4.4 Inorganic Lead

7.4.4.1 Inorganic lead may be present in paints and coatings used on tanks and piping and may also be present in sludge, residue and products such as gear lubricants and metal working fluids containing inorganic lead additives. Exposure to inorganic lead can occur when performing the following:

— sludge, deposit and residue removal;

— grinding, blast cleaning, and scraping;

— abrasive blasting.

7.4.4.2 Lead-in-paint tests shall be performed inside and/or on the outside the tank prior to abrasive blasting of internal or external linings that have not been certified lead-free.

7.4.4.3 Entry supervisors shall assure that workers are aware of employer procedures and applicable regulatory requirements for control of exposures to inorganic lead and lead dust during handling, removal, and disposal and that safety requirements are followed.

7.4.4.4 Entry supervisors shall assure that permits require and workers use appropriate lead hazard respiratory protection and personal protective clothing and equipment during operations involving potential contact with products, sludge, residue, and dust containing inorganic lead.

7.4.4.5 Employers shall establish and implement procedures for decontamination and disposal of contaminated clothing and materials and provide workers with appropriate facilities for washing and changing clothes.

7.4.4.6 Employers shall establish and implement procedures for testing and disposal of blasting grit, paint deposits and residue that contain inorganic lead.

7.4.5 Aromatics

7.4.5.1 Some aromatic compounds found in petroleum hydrocarbons such as benzene, have been determined to have the potential to cause cancer.

7.4.5.2 The employer shall establish and the entry supervisor shall implement requirements for safe entry and other work that addresses exposure to aromatic hydrocarbons, where there is a potential for such exposure.

7.4.5.3 A qualified person shall determine the requirements and the entry supervisor shall assure that workers use the appropriate protective equipment, depending on the potential concentration, method and amount of exposure to aromatic hydrocarbons.

7.4.5.4 Employers shall establish and entry supervisors shall implement procedures for decontamination and disposal of contaminated clothing and materials and provide workers with appropriate facilities for changing clothes and washing hands.

7.4.5.5 Employers shall establish and implement procedures for testing and disposal of product, sludge, deposits and residue that contain aromatic hydrocarbons.

7.4.6 Naturally Occurring Radioactive Materials (NORM)

7.4.6.1 Crude oil (and sludge or residue from crude oil tanks) may contain naturally occurring radioactive materials (NORM).

7.4.6.2 The employer shall establish and the entry supervisor shall implement requirements for safe entry and work that addresses NORM, where there is a potential for such exposure.

7.4.6.3 A qualified person shall determine the requirements and the entry supervisor shall assure that workers use the appropriate protective equipment, depending on the potential concentration, method and amount of exposure to naturally occurring radioactive materials (NORM).

7.4.6.4 Employers shall establish and entry supervisors shall implement procedures for decontamination and disposal of contaminated clothing and materials and provide workers with appropriate facilities for changing clothes and washing hands.

7.4.7 Other Toxic Materials

7.4.7.1 Entry supervisors shall assure that a qualified person reviews applicable SDSs and other available information covering the products, sludge, residue or materials contained in the tank in order to determine if there is potential for exposure to other toxic substances, including, but not limited to, aromatic hydrocarbons, inert gas, and radioactive materials.

7.4.7.2 A qualified person shall also review SDSs and available information on the materials used to clean the tank and determine if there is a potential for incompatibility or exposure to toxic substances.

7.4.7.3 The employer shall establish and the entry supervisor shall implement requirements for safe entry and work where there is a potential for exposure to other toxic substances.

7.4.7.4 A qualified person shall determine the requirements and the entry supervisor shall assure that workers use the appropriate protective equipment, depending on the potential concentration, method, and amount of toxic exposure.

7.4.7.5 Entry supervisors shall assure that applicable regulatory requirements and facility procedures for control of exposures to toxic materials are followed during tank cleaning operations, material handling, and waste disposal.

7.4.7.6 Employers shall establish and entry supervisors shall implement procedures for decontamination and disposal of contaminated clothing and materials and provide workers with appropriate facilities for changing clothes and washing hands.

7.5 Physical and Other Hazards

7.5.1 General

Physical and other hazards may be present or created both inside and outside the tank during tank cleaning and entry operations. Workers shall be aware of potential physical hazards and the symptoms of physiological and psychological hazards.

7.5.2 Requirements

An entry supervisor or a qualified person shall determine and evaluate the potential physical and other similar hazards. The entry supervisor shall conduct a safety review of the tank and surrounding area and institute necessary precautions and control measures.

7.5.3 Hazard Identification

7.5.3.1 Workers shall be aware of physical and other hazards that could be potentially encountered during tank cleaning operations including, but not limited to, the following.

7.5.3.2 Physical hazards related to a tank's function or design, including, but not limited to, restricted entry and egress, tripping or bumping into internal tank components, piping, or roof supports and falling into sumps or holes in the bottom.

7.5.3.3 Physical hazards related to a tank's condition, including, but not limited to, corroded roofs, cracks, and openings in bottoms, poorly supported or corroded stairways and ladders, sunken roofs, or the collapse of landed floating roofs by either spiraling or dropping down upon workers (see 7.6).

7.5.3.4 Physical hazards related to a tank's location, including, but not limited to, being next to a tank that is taking in product and releasing flammable vapors, being near a process unit that is venting or relieving hazardous vapors or gases to the atmosphere or being close to an outside potential ignition source, such as a public highway or close neighbor.

7.5.3.5 Physiological hazards, including, but not limited to, heat stress (see 7.7) and cold stress inside tanks and exposure to extreme cold or inclement weather outside of tanks.

7.5.3.6 Psychological hazards, including, but not limited to, claustrophobia.

7.6 Floating Roof Hazards

Floating roof hazards include the following.

1) Catastrophic failure due to loss of vertical support from support leg failure, unsupported legs, suspension cable failure, floating roof deterioration, and overload (water, ice, snow, or product on the deck or in pontoons).

2) Catastrophic failure due to translation, such as may occur when perimeter seals are inadequate or removed.

3) Catastrophic failure due to rotation, such as may occur when anti-rotation devices (poles, bars, perimeter seals, cable suspension systems) are inadequate, deteriorated, or do not exist. Floating roofs without seals are of particular concern.

4) Fire caused by product in pontoons, product-saturated seals, and product in roof drains and an ignition source.

5) Fire caused by trapped vapors between primary and secondary perimeter seals.

6) Ergonomic hazards, especially if the floating roof is landed on low legs.

7.7 Heat Stress

The entry supervisor shall ensure that heat stress is addressed, including consideration of the temperature, humidity, heat index, solar load, exposure times and PPE as applicable. The entry supervisor shall be aware that air conditioning to cool and dehumidify the space may be desirable to allow increased exposure times for workers.

The entry supervisor shall be aware of and implement appropriate engineering and administrative controls including:

— air conditioning;

— additional ventilation;

— adiabatic cooling with air horns;

— evaporative cooling by spraying the tank exterior with water;

— shaded areas and drinking water;

— job rotation (control of exposure time).

7.8 Pyrophoric Iron Sulfide

Sulfur compounds in sour stock can react with steel to form pyrophoric iron sulfide deposits. When air contacts these deposits, a heat-generating chemical reaction can occur, creating temperatures high enough to ignite a flammable vapor-in air mixture. Typical affected products include aromatic tars, aromatic gas, asphalt, liquid sulfur or sour crude oil and products.

Entry supervisors shall determine the potential for pyrophoric iron sulfide ignition. If the potential exists, keeping surfaces and deposits moist shall be considered.

7.9 Hazard Assessment

The employer shall perform a hazard analysis and establish the conditions and precautionary requirements for entry into tanks that are classified as a:

— permit required confined space;

— non-permit required confined space;

— and non-confined space.

8 Personal Protective Equipment

8.1 Protective Clothing and Equipment

8.1.1 General

Employers shall provide and workers shall wear protective clothing and equipment as required by applicable regulations. Personal protection shall be appropriate for the potential hazards, atmospheric exposure, tank conditions and the task, operation or activity to be performed.

8.1.2 Selection

8.1.2.1 Entry supervisors shall evaluate the potential exposures and hazards and determine the personal protection required by workers. The following shall be considered.

8.1.2.2 Impervious clothing, gloves and footwear, to protect the skin. Entry supervisors shall review and understand the potential consequences of using impervious clothing in areas subject to heat stress.

8.1.2.3 Light colored clothing to enhance visibility and to assist in identifying contamination on clothing.

8.1.2.4 Fire retardant impervious coveralls or flame resistant clothing or coveralls to protect from a potential fire.

8.1.2.5 Hard hats, head coverings, work gloves, safety shoes and boots, face shields, and goggles to minimize skin and eye exposure to hazardous substances and physical hazards.

8.1.2.6 The capability of certain clothing materials to generate static electricity (producing a static discharge).

8.1.3 Toxic Contamination

Entry supervisors shall assure that if worker's skin, eyes, clothing, or equipment becomes contaminated with hazardous substances or toxic materials, appropriate response actions are immediately taken. Entry supervisors shall assure that such response includes one or more of the following, as required:

a) decontaminating the person by providing necessary personal hygiene and showering;

b) decontaminating and/or disposing of contaminated clothing and equipment;

c) determining required first aid or medical care;

d) determining the extent of exposure and required medical surveillance or testing.

8.1.4 Regulatory Requirements

Employers and entry supervisors shall be aware of and implement the requirements of OSHA 29 *CFR* 1910.132-6, 1926.28 and/or other regulatory requirements applicable to the use of personal protective equipment.

8.2 Respiratory Protection

8.2.1 General

Employers shall establish and implement proper respiratory protection programs to protect tank workers from occupational injuries, illnesses, and diseases caused by breathing in air that is contaminated with harmful substances.

8.2.2 Respirator Selection

8.2.2.1 Entry supervisors shall ensure that available information covering materials contained in the tank or used to clean the tank is reviewed by a qualified person in order to determine and select appropriate respiratory protection. This includes review of SDSs, product, sludge, and residue information and specific health standards.

8.2.2.2 Employers shall provide workers with respirators that are appropriate and suitable for the potential exposures and the purpose intended. Employers shall assure that equipment provided is not subject to deterioration or corrosion caused by product or residue in the tank, by chemicals used to clean the tank or by solvents contained in tank coatings, paint and liners.

8.2.2.3 Employers shall assure that the respirators furnished to employees provide adequate respiratory protection against the particular hazard for which they are designed in accordance with standards established by competent authorities. (In the United States, competent authorities include the U.S. Department of Labor, Mine Safety and Health Administration and the U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health.)

8.2.2.4 Entry supervisors shall assure that appropriate respiratory protective equipment is selected, designated and worn by workers as established by the entry and work permits.

8.2.3 Regulatory Requirements

Employers, qualified persons and entry supervisors shall be aware of and review the appropriate requirements of government regulations and industry standards that are applicable to the use of respiratory protective equipment. (In the United States, this includes, but is not limited to, ANSI Z88.1, OSHA 29 *CFR* 1910.134; 1910.1000; 1910.1025 and 1910.1028.)

8.2.4 Training

Employers shall assure that entry supervisors and workers using respiratory protection receive instruction and training in the fit testing, inspection, cleaning and use of respiratory protective equipment required by the permit and provided by the employer.

8.2.5 Respiratory Protection Program

Employers shall establish, implement, and maintain respiratory protection programs as required by government regulations (in the United States, OSHA 29 *CFR* 1910.134 covers respiratory protection requirements), industry standards and facility policy. The respiratory protection programs shall include the following requirements.

1) Written respirator program including procedures governing the selection, inspection, maintenance, and use of respirators.

2) Respirator selection based on the potential hazards to which users may be exposed.

3) Instruction and training for users in the proper fit testing, inspection, wearing, and use of respirators and their limitations.

4) Procedures for cleaning and disinfecting respirators after each use.

5) Provision of convenient, clean and sanitary storage locations for respirators.

6) Respirator inspection after each use and during cleaning.

7) Inspection of emergency use respirators after each use and at least once every month, if not used.

8) Appropriate surveillance of work area conditions and monitoring the degree of employee exposure or stress while using respirators.

9) Respirator clearance examination by a health care professional to assure that workers assigned to tasks requiring the use of respirators are physically able to use the required respiratory protective equipment.

10) Periodic reviews and evaluations to determine the continued effectiveness of the written respiratory protection program including and updating the respiratory protection program when necessary.

8.2.6 Fitting, Testing, and Checking Respirators

8.2.6.1 Employers shall provide every respirator user with a properly fitting respirator. Training shall include demonstration and practice in the correct way to wear the respirator, its proper adjustment and fit checking instructions to determine that it fits properly.

8.2.6.2 To assure proper protection, the users shall check the face piece fit each time they don their respirators.

8.2.6.3 Fit checks performed by employees shall not be confused with the qualitative or quantitative fit testing that is conducted initially and periodically thereafter, by a qualified person, in accordance with regulatory or employer (owner/operator and contractor) requirements.

8.2.6.4 Respirators shall not be worn when conditions prevent a good face seal.

8.2.7 Breathing Air Cylinders

8.2.7.1 Employers shall require and a qualified person shall verify that breathing air supplied to respirators meets the appropriate regulatory requirements for breathing air, such as the specification for Grade D breathing air as described in CGA G-7.1-1966.

8.2.7.2 Entry supervisors shall assure that approved (Grade D, or equivalent) breathing air is supplied to respirators from approved air supply cylinders.

8.2.7.3 Breathing air cylinders shall be equipped with low level indicators or an alarm system.

8.2.8 Breathing Air Compressors

8.2.8.1 The use of breathing air compressors shall be allowed only when permitted by the employer.

8.2.8.2 A qualified person shall inspect and verify that breathing air compressors (or air compressors provided with approved purification system) used to supply breathing air are approved for use and in good operating condition. Breathing air shall be Grade D minimum, or equivalent.

8.2.8.3 The entry supervisor shall assure that the breathing air compressor is located upwind of the tank and the fresh air intake is located above ground level, away from potential sources of exhaust gases, fumes, or flammable or toxic atmospheres from both internal (from the tank) and external (outside the tank) sources. These sources include internal combustion engine exhausts, vapors discharged from the tank, vapors emitted from vacuum truck operations, and vapors from nearby tanks during product receipts.

8.2.8.4 Entry supervisors shall assign a qualified person to act as a bottle watch to continuously monitor air compressor intake air quality, provide a constant breathing air supply, and assure that the compressor is protected from physical damage. Bottle watches shall immediately notify entrants to switch to emergency bottled air and leave the tank in case of compressed air supply contamination or failure.

8.2.9 Location of Breathing Air Cylinders

8.2.9.1 Entry supervisors shall assure that breathing air cylinders are properly located to protect the air supply and the bottle watch from potential exposure to flammable or toxic vapors from both internal (from the tank) and external (outside the tank) sources.

8.2.9.2 The bottle watch shall maintain air supply cylinders in a secured, upright position, and properly switch cylinders as required to provide a constant air supply and assure that the cylinders are protected from physical damage and contamination.

8.2.9.3 The entry supervisor shall assure that a qualified person inspects breathing air supply systems prior to each use and periodically during use, to ensure the integrity and good condition of the air supply.

8.2.9.4 Bottle watches shall immediately notify entrants to switch to emergency bottled air and leave the tank in case of cylinder air supply failure.

8.2.10 Air Supply Lines, Hoses, and Couplings

8.2.10.1 The entry supervisor shall assure that a qualified person inspects breathing air supply systems prior to each use and periodically during use, to ensure the integrity and good condition of the air supply lines, hoses, and airline couplings.

8.2.10.2 Employers shall provide breathing air line couplings that are not compatible with outlet connections for other air or gas systems in the facility, including, but not limited to, nitrogen, industrial air, hydrogen, and oxygen.

8.2.10.3 Entry supervisors shall assure that breathing air supply lines are isolated from plant utilities by use of non-matching connectors to prevent inadvertent servicing of air line respirators with non-respirable gases or oxygen.

8.2.10.4 The entry supervisor and bottle watch shall assure that breathing air supply lines, hoses, and couplings are not used for supplying anything other than breathing air.

9 Tank Cleaning/Entry Personnel

9.1 General

9.1.1 Workers

Tank cleaning/entry personnel (workers) shall be qualified persons. These workers include:

a) testers,

b) bottle watches,

c) vacuum truck operators,

d) operations personnel,

e) safe (cold) work and hot work permit issuers,

f) entry supervisors,

g) tank cleaning workers,

h) sludge and residue handlers,

i) rescuers,

j) tank inspection workers,

k) repair workers,

l) abrasive blasting and coating/lining workers.

9.1.2 Responsibilities

Employers shall assure that tank cleaning personnel are familiar with employer tank cleaning program requirements and all aspects of tank cleaning operations, including the following.

1) Awareness and recognition of potential hazards.

2) Types, design, configuration, physical hazards, and limitations of the tanks to be entered.

3) Hazards and properties of the materials (product, sludge, and residue) to be removed from tanks and the materials (chemicals, etc.) used for cleaning and lining of tanks.

4) Requirements for safe entry, safe (cold) work, and hot work.

5) Confined space classification requirements.

6) Vapor and gas freeing, degassing, and ventilation requirements.

7) Lockout/tagout requirements.

8) Sources of ignition and requirements for bonding and grounding.

9.1.3 Requirements

Employers shall assign qualified tank workers who are familiar with and will assure compliance with applicable government regulations, industry standards and facility safety procedures.

9.2 Entry Supervisors

9.2.1 General

Employers shall assure that entry supervisors are:

— assigned to each tank entry operation;

— trained and qualified comply with employer tank cleaning/entry requirements, regulatory requirements, and to safely direct tank work.

Employers shall assure that only entry supervisors have the authority to issue entry permits.

9.2.2 Responsibilities

9.2.2.1 Only entry supervisors may issue permits for tank entry, safe (cold) work and hot work. Workers may not enter a tank without a tank entry permit issued and signed by an entry supervisor. Entry supervisors are responsible for the following.

9.2.2.1.1 Recognize the actual and potential hazards that may be encountered during tank work the mode, signs, symptoms or consequences of exposure to hazardous or toxic substances.

9.2.2.1.2 Classify a tank as a permit required confined space, a non-permit required confined space or a non-confined space.

9.2.2.1.3 Determine the status of the tank, safe entry requirements and verify that conditions necessary for safe entry, safe (cold) work, and hot work inside the tank have been met before issuing and signing the entry permit.

9.2.2.1.4 Determine the requirements and frequency of monitoring atmospheric conditions.

9.2.2.1.5 Determine the personal protection requirements for workers and indicate these on entry, safe (cold) work, and hot work permits regardless whether entry is into a permit-required confined space, a non-permit required confined space, or into a non-confined space.

9.2.2.1.6 Verify that assigned workers are qualified persons who are capable of performing their assigned duties.

9.2.2.1.7 Verify and document before issuing any permits that:

— all required testing has been conducted;

— entry requirements and conditions and all specified entry procedures are satisfied;

— appropriate entries have been made on the permits, and that required equipment is in place.

9.2.2.1.8 Assure that rescue services are available and that attendants are provided with an operable means of summoning rescuers.

9.2.2.1.9 Prohibit the entry of and assure that unauthorized or unqualified persons who may attempt to enter the tank or work area are immediately removed.

9.2.2.1.10 Determine permit expiration and cancellation criteria:

— cancel permits upon expiration or whenever conditions change to cause the tank or work area to become more hazardous;

— terminate entry and direct entrants to immediately evacuate the tank.

9.2.2.1.11 Ensure conditions are reevaluated following entry permit cancellation or expiration and reissue permits in accordance with current conditions.

9.2.2.1.12 Ensure that entry conditions and work operations remain consistent with the terms of the permits and safe conditions are maintained whenever responsibility for an operation is transferred and at intervals required by the permit.

9.2.2.1.13 Perform no duties that might interfere with the primary duty to determine entry conditions and requirements, supervise tank cleaning/entry operations, and issue and cancel permits.

9.2.2.1.14 Perform assigned duties and assure tank work is conducted in accordance with the employer's confined space program, industry standards, facility procedures and applicable government regulations.

9.2.2.1.15 Evaluate and determines the need for attendants during entry into spaces that are classified as non-confined spaces.

9.2.2.1.16 Classify a tank with a floating roof that has not been secured in accordance with this standard as a permit required confined space.

9.2.2.1.17 Classify empty tanks as permit required confined spaces entry and be aware that the following conditions may exist in such tanks:

a) the empty tank may be void of oxygen due to rusting or inerting;

b) the empty tank may have a flammable atmosphere from sludge, residue or product entering the tank through lines and connections or seeping into the tank from leaking bottoms or columns;

c) the tank may have a toxic atmosphere from a variety of internal or external sources.

9.2.2.1.18 Ensure that permitting is in accordance with Section 11 of this standard.

9.2.2.1.19 Recognize that the level of entry posing the least risk is preferable. Entry level risk ranking in descending order is as follows:

a) permit required confined space;

b) non-permit required confined space;

c) non-confined space.

9.2.3 Requirements

Employers shall ensure that each entry supervisor is familiar with and can recognize the actual and potential hazards that may be encountered during decommissioning, tank cleaning and returning to service operations, including information on the mode, signs, symptoms or consequences of exposure to hazardous or toxic substances on entry supervisors, testers, attendants, entrants, standby persons, workers, and rescuers.

9.3 Entrants

9.3.1 General

9.3.1.1 Entry supervisors shall only allow employees who are qualified and designated by their employers as entrants, to enter into tanks classified as permit required confined spaces and non-permit required confined spaces.

9.3.1.2 Entry supervisors shall consider testers, attendants, standby persons, permit supervisors, rescuers, and workers entering permit required or non-permit required confined spaces to perform testing, inspection, cleaning, safe (cold) work, hot work, rescue, or other activities, to be entrants during these activities.

9.3.1.3 Entry supervisors shall not consider workers entering tanks classified as non-confined spaces to be entrants.

9.3.1.4 The names of all entrants and their duties shall be indicated on the entry permit by the entry supervisor.

9.3.2 Responsibilities

9.3.2.1 Employers and entry supervisors shall assure that each designated entrant:

9.3.2.1.1 Knows and recognizes that entry into a permit required or non-permit required confined space is considered to occur as soon as any part of the entrant's body breaks the plane of an opening into the confined space.

9.3.2.1.2 Is qualified, trained and physically fit to perform work inside permit required and non-permit required confined spaces.

9.3.2.1.3 Knows the actual and potential hazards that may be encountered during tank entry, including information on the mode, signs, symptoms or consequences of exposure to hazardous or toxic substances and are aware of how to recognize potential behavioral effects of hazardous or toxic exposure on themselves.

9.3.2.1.4 Communicates with attendants as necessary to enable attendants to monitor entrant status and to enable the attendant to alert entrants of the need to stop work or evacuate the space.

9.3.2.1.5 Alerts the attendant upon recognizing any warning sign or symptom of exposure including heat or cold stress, noticing any potential hazard or when detecting a prohibited condition.

9.3.2.1.6 Properly uses personal protective clothing and equipment, respiratory protection, communication, testing and monitoring, rescue and tank cleaning equipment as required by the entry and work permits.

9.3.2.1.7 Knows when, where and how to expeditiously exit from the tank when one or more of the following items occurs:

1) entrant is ordered to exit by the attendant or entry supervisor or by an evacuation alarm;

2) entrant observes a potentially dangerous situation or experiences a symptom of a stressful condition and hazardous or toxic exposure;

3) entrant detects a condition that is prohibited by the permit or operating procedures;

4) the attendant cannot effectively and safely perform attendant duties;

5) the permit expires or is cancelled.

9.3.2.1.8 Performs no duties that might interfere with their primary duties.

9.3.2.1.9 Performs duties in accordance with the employer's confined space program, facility procedures and applicable government regulations (see ANSI Z117.1, NFPA 326 and OSHA 29 *CFR* 1910. 134).

9.3.2.1.10 Is aware of emergency evacuation procedures including alarms, egress routes and assembly areas.

9.3.2.1.11 Knows that a tank with a floating roof that has not been properly secured in accordance with this standard is to be considered a permit required confined space.

9.4 Attendants

9.4.1 General

When the tank to be entered is classified as a permit required confined space or a non-permit required confined space, employers shall assign at least one qualified person to be stationed as an attendant outside the tank for the duration of entry operations. (Attendants are not required outside tanks classified as non-confined spaces.) The entry supervisor shall include attendant's names and their duties on the entry permit.

9.4.2 Responsibilities

9.4.2.1 Employers and entry supervisors shall assure that each assigned attendant:

9.4.2.1.1 Knows the actual and potential hazards that may be encountered during tank entry and work, including information on the mode, signs or symptoms, or consequences of exposure of hazardous or toxic substances on entrants or themselves.

9.4.2.1.2 Is aware of and can recognize potential behavioral effects of hazardous or toxic exposure on entrants and themselves.

9.4.2.1.3 Communicates with entrants as necessary to monitor entrant status and to alert entrants of the need to stop work or evacuate the space.

9.4.2.1.4 Continuously maintains an accurate count of entrants within the tank and ensures that the means used to identify entrants accurately identifies those who are inside the tank.

9.4.2.1.5 Knows not to enter the tank for any reason and remains outside the entrance into the tank at all times during entry operations until relieved by another attendant or until the entry permit is expired or cancelled and all entrants have left the permit required confined space.

9.4.2.1.6 Monitors entrants' activities and physical condition and is attentive of the work being performed inside the tank and the conditions inside and outside the tank that could impact on the entrants' safety or health so as to determine whether or not it is safe for entrants to remain inside and conduct work or activities in the tank.

9.4.2.1.7 Orders entrants to evacuate the tank immediately whenever one or more of the following occur.

1) A condition is detected that is prohibited by the permit or operating procedures.

2) Undesired behavioral effects of hazard exposure on an entrant are detected.

3) A condition or potentially hazardous situation is detected inside or outside the tank that could endanger the entrants.

4) The attendant cannot effectively and safely perform all assigned attendant duties.

5) The permit expires or is cancelled.

9.4.2.1.8 Takes the following action when unauthorized persons approach or attempt to enter a tank classified as a permit required confined space or non-permit required confined space:

1) warns unauthorized persons that they must stay away from the tank;

2) directs the unauthorized persons to exit immediately if they have entered the tank;

3) immediately informs all entrants and the entry supervisor if unauthorized persons have entered, attempted to enter or approached the tank.

9.4.2.1.9 Determines if entrants may need assistance to escape from permit required confined space hazards and, if so, summons designated rescuers or authorized emergency services immediately.

9.4.2.1.10 Does not leave the assigned location until all entrants have vacated the tank or is properly relieved, even to attempt a rescue.

9.4.2.1.11 Performs non-entry rescue as specified by the employer's procedures and rescue program. Attempts non-entry rescue using the retrieval line from outside the tank only when proper equipment is in place and takes appropriate precautions to assure that the rescue attempt will not present further hazards to the entrant or attendant.

9.4.2.1.12 Performs rescue that requires entry only after being relieved and only when provided for in the employer's permit entry program. The attendant shall be properly equipped, trained, qualified and assigned to be a rescuer.

9.4.2.1.13 Performs no duties that might interfere with the primary duty to monitor the tank and adjacent area and protect the entrants.

9.4.2.1.14 Performs duties in accordance with the employer's confined space program, facility procedures and applicable government regulations.

9.4.2.1.15 Does not allow entry into a tank with a floating roof that has not been properly secured in accordance with this standard without a permit required confined space permit.

9.5 Non-Entry Supervisor Permit Issuers

Owner/Operators are responsible to issue hot work permits in areas required for access to the work site (e.g., roads and dikes) and in areas that could affect the worksite. (e.g. adjacent tanks, processes, or other work).

10 Entering and Working Inside the Tank

10.1 General

10.1.1 Permits shall be issued for entry into a confined space tank and for all safe (cold) and hot work conducted inside the tank. Work permits shall also be issued by entry supervisors or qualified persons for all work performed outside the tank associated with the tank cleaning/entry operations.

10.1.2 Entry into tanks for the initial assessment of atmospheric and physical conditions shall be considered as permit required confined space entry until the results and evaluation of tank atmospheric testing demonstrate otherwise.

10.1.3 Tanks shall be considered permit required confined spaces until atmospheric testing has been performed, physical hazards have been addressed and a qualified person has determined that conditions are safe for entry at other classification levels. This includes tanks that:

a) have been previously cleaned but have been closed and inactive;

b) are being cleaned that have been closed overnight or for more than a day;

c) have been closed for an extended period during the cleaning process, including, but not limited to, shift changes, permit cancellation or facility emergency;

d) have floating roofs not secured in accordance with this standard.

10.2 Entry Permit

10.2.1 General

10.2.1.1 Before anyone may enter a tank that is a permit required or a non-permit required confined space, entry supervisors shall issue written entry permits attesting that all required testing and safeguarding has been performed and that the entry requirements on the permit have been satisfied.

10.2.1.2 A copy of the written permit shall be posted at the tank entry point or available at the tank cleaning work site.

10.2.1.3 Any problems arising during a tank entry shall be noted on the permit by the entry supervisor.

10.2.1.4 Employers shall maintain copies of entry permits on file for at least one year for analysis and review in order to facilitate appropriate permit program revisions.

10.2.2 Permit Requirements

10.2.2.1 Entry supervisors shall assure that entry permits include, but are not limited to, the following information.

10.2.2.1.1 Identification and specific location of the permit required confined space to be entered.

10.2.2.1.2 Purpose of the entry, work to be performed, issue date, time of issue and the authorized duration of the entry permit.

10.2.2.1.3 Potential hazards of the permit required confined space to be entered and acceptable entry conditions.

10.2.2.1.4 Measures used to isolate the permit required and non-permit required confined spaces and to eliminate or control hazards before and during entry (and reentry, upon reissue of the permit) including, but not limited to, the following:

1) lockout and tag out;

2) blinding and blanking or blocking and bleeding;

3) purging, vapor and gas freeing, inerting, flushing, degassing, and ventilating.

10.2.2.1.5 Conditions that shall require the permit to be canceled, work to stop and entrants to leave the tank, including, but not limited to, the following:

1) approaching electrical storms, tornadoes or other bad weather conditions;

2) emergencies occurring either inside or outside the tank;

3) flammable liquids receipt into a nearby tank with the potential to emit vapors into the tank cleaning work area;

4) hydrocarbon or toxic atmospheres within the tank at levels above those permitted for safe entry;

5) entry by an unauthorized person;

6) standing water, ice, or product on a floating roof deck or inside pontoons;

7) changed condition of a floating roof that could indicate instability not addressed by the method of securing the floating roof including:

   — bowing or buckling of roof legs;

   — missing or damaged roof leg pins or cables;

   — sagging of the floating roof deck;

   — removal of perimeter seals without securing the floating roof against translational; and

   — broken or missing anti-rotation guide or pole;

   — distorted or broken floating roof restraints.

10.2.2.1.6 Times and results of the atmospheric testing (initial, continuous and/or periodic) conducted, accompanied by the names or initials of the qualified persons conducting the testing.

10.2.2.1.7 Names of the designated attendants and entrants (and workers assigned to work around the outside of the tank) and the means of communication to be used by entrants and attendants to maintain contact with each other during the entry.

10.2.2.1.8 Designated emergency personnel available and the means of communication to use and the numbers to call, for summoning such services, if designated qualified rescue personnel are not available at the work site.

10.2.2.1.9 Equipment to be used, including:

1) personal protective clothing and equipment and respiratory protection;

2) atmospheric testing equipment;

3) alarms and fire protection equipment;

4) vapor and gas freeing, degassing, ventilation and air supply equipment;

5) tank cleaning materials and equipment;

6) product, sludge and residue removal and disposal equipment;

7) emergency rescue equipment specific to the tank and the potential hazards;

8) non-destructive testing equipment;

9) vacuum trucks;

10) abrasive blasting and liner application equipment;

11) welding and cutting machines;

12) generators.

10.2.2.1.10 Any other permits, including hot work and safe (cold) work permits or work authorizations issued to perform work in or around the tank during entry.

10.2.2.1.11 Other information whose inclusion is necessary on the permit in order to insure entrant safety, the following:

1) product information such as SDSs;

2) planned receipts into a nearby tank;

3) activities elsewhere in the facility which could affect the entry;

4) a lockout/tagout (isolation) listing including names of persons controlling locks.

10.2.2.1.12 Required warnings, including, but not limited to, posted permits, signs and notices, barriers, and lockout/tagout tags.

10.2.2.1.13 The means of protecting tank openings with temporary barriers or covers to prevent entrants from falling into openings and to keep foreign objects and undesirable persons from entering the tank both during operations and when operations are not in progress.

10.2.2.1.14 The individual, by name, currently designated to be the entry supervisor, with a space for the signature or initials of the entry supervisor who originally authorized entry and the entry supervisor(s) who may subsequently authorize reentry, if the permit was reissued.

10.3 Floating Roof Stabilization

Floating roofs shall be stabilized to control vertical, translational and rotational movement when workers are working under the floating roof.

10.4 Heat Stress

Employers shall anticipate the potential for worker heat stress and provide appropriate administrative and engineering controls. At a minimum, the factors that can cause heat stress and the administrative controls listed in Section 7.7 shall be considered.

10.5 Continuous Forced Air Ventilation

10.5.1 General

10.5.1.1 Entry supervisors shall be aware of and institute appropriate ventilation procedures to control exposures so they remain within permit limits during tank entry.

10.5.1.2 Because the potential exists for exposure to flammable vapors and toxic atmosphere, entry supervisors shall require forced ventilation to be continued throughout the tank cleaning operation, even if the initial and subsequent atmospheric test results are acceptable.

10.5.1.3 Entry supervisors shall adhere to applicable regulatory or facility requirements for a minimum number of air changes per hour inside the tank.

10.5.2 Vapor and Gas Sources

Entry supervisors and workers shall be familiar with both typical and unusual areas where liquid product, flammable vapors and gas, toxic gas, residue, or sludge may collect or remain in the tank, including, but not limited to, the following:

1) low spots on tank bottoms, in sumps and holes and beneath leaking tank bottoms;

2) inside of double walls and double bottoms of tanks;

3) inside columns, roof supports, fire foam systems, pontoons, floating swing lines, roof drains, internal piping, and heating coils;

4) saturated in flotation and insulation materials, or in rust, residue and other accumulations on internal tank surfaces;

5) between primary and secondary seals on floating roof.

10.5.3 Potential Hazards

Entry supervisors shall review the potential hazards associated with tank cleaning and other work during forced air ventilation and indicate the requirements for safe operations and personal protective equipment on the entry permit.

10.6 Tank Safe (Cold) Work, Maintenance, and Repairs

Entry supervisors shall issue permits for safe (cold) work inside tanks for permit required and non-permit required confined spaces. Examples of safe (cold) work include:

a) spraying and epoxying;

b) painting;

c) installing liners;

d) performing visual and intrinsically safe inspection methods;

e) performing atmospheric testing;

f) installing seals;

g) bolting of piping, heating coils and roof drains;

h) water cutting operations.

10.7 Undesirable Product, Sludge, and Residue Disposal

Employers shall assure that disposal of undesirable product, sludge, residue and cleaning materials from tank cleaning operations and all contaminated tank appurtenances removed from service complies with applicable government regulations, facility policy and employer procedures.

Entry supervisors shall determine the potential hazards associated with the handling, removal and containment of undesirable product, sludge, residue, cleaning materials and contaminated appurtenances and indicate the requirements for safe handling and personal protective equipment on the entry and work permits.

11 Hot Work and Tank Repairs

11.1 General

11.1.1 Examples of Hot Work

Entry supervisors shall issue permits for hot work inside or around the outside of tanks, regardless of the classification of the tank. Examples of hot work include:

a) welding,

b) cutting,

c) burning,

d) grinding,

e) drilling,

f) heating,

g) spray washing,

h) steam cleaning,

i) vacuum truck operations,

j) abrasive blasting,

k) use of internal combustion engines,

l) use of non-explosion proof or improperly classified electric equipment.

Qualified persons (e.g. Owner/Operators) may issue facility hot work permits for dike entry, worksite access, etc., but the entry supervisor is the only one authorized to issue hot work permits for the tank work. The tank hot work permit may part of the entry permit or attached to the entry permit.

11.1.2 Hot Work Program

Employers shall develop and establish a hot work program and entry supervisors and permit issuers shall implement the prescribed procedures for safe (cold) work and hot work in and around tanks.

11.1.3 Hot Work Requirements

Entry supervisors and hot work permit issuers shall assure that hot work inside and around the outside of tanks complies with all of the requirements of this standard, applicable government regulations, and facility procedures for safe entry and work inside tanks.

11.2 Hot Work Permits

11.2.1 Permit Issuance

Hot work permits shall be issued before hot work is allowed to begin inside or around the outside of tanks.

11.2.2 Permit Conditions

Hot work permit issuers shall determine the potential hazards and assure that appropriate controls and precautions are taken to protect workers from flammable and toxic vapors, toxic fumes and other harmful exposures when hot work is conducted inside and around the outside of tanks, in areas required for access to the work site (e.g. roads and dikes) and in areas that could affect the worksite. (e.g. adjacent tanks, processes, or other work). Entry supervisors and qualified persons issuing hot work permits shall:

1) determine and indicate on the permits all conditions under which the hot work permit will be cancelled, work is to stop and workers are to exit the tank and/or evacuate the area;

2) specify the requirements for any local exhaust ventilation, types of respiratory protection, and/or atmospheric exposure monitoring on the entry and hot work permits;

3) require the tank atmosphere to be tested at the start of work and retested (following extended breaks or work stoppage) before the hot work permit is reissued and work resumes.

11.2.3 Permit Requirements

11.2.3.1 During hot work, entry supervisors shall assure that the flammable vapor-in-air atmosphere in the tank is not in excess of 0 % of the lower explosive (flammable) limit, that the oxygen level does not exceed 23.5 % (and is not less than 19.5 %) and that the permitted exposure limits for toxic vapors, fumes and substances are not exceeded.

11.2.3.2 Entry supervisors shall assure that ventilation is continued during hot work inside tanks classified as permit required, non-permit required confined spaces and non-confined spaces to minimize any accumulation of flammable and toxic vapors or toxic fumes emanating from such sources.

11.2.3.3 Entry supervisors shall determine the need for local ventilation (a flexible hose with an air blower) to improve atmospheric levels at specific work locations (for example, at the spot where welding or cutting occurs) during hot work inside tanks classified as permit required, non-permit required confined spaces and non-confined spaces.

11.3 Hot Work Hazards

11.3.1 General

11.3.1.1 The entry supervisor and workers shall be aware that the potential exists for hazardous vapors and fumes to be generated through the application of heat and provide for appropriate protective measures when issuing the hot work permit.

11.3.1.2 The entry supervisor shall require that any tank surfaces to be heated. including, internal and external roofs, internal and external structural supports, columns, piping, scaffolding, decking, and pontoons, are free of flammable and combustible liquids and vapor, ignitable rust and scale, waxes and other combustible deposits.

11.3.1.3 The entry supervisor shall determine the quantity and potential composition of fumes generated during hot work by investigating the materials being welded or worked on including deposits, residue, coatings, or paint being heated or burned and the products of combustion of welding rods.

11.3.2 Hazard Awareness

11.3.2.1 Workers performing hot work in and around the outside of tanks shall be aware of the following potential hazards.

11.3.2.1.1 Deposits are sometimes hidden on the upper surfaces of roof rafters and similar locations within the tank and wooden roof supports may be coated or saturated with hydrocarbons.

11.3.2.1.2 Flammable and toxic liquids and vapors may enter a tank through leaks in the tank bottom or may evolve from other spaces including pipe-column roof supports, chambers, swing lines, pontoons, and sumps.

11.3.2.1.3 Repairs to tank bottoms may create a potential fire or explosion hazard, a toxic exposure hazard or there may be a reduction in the oxygen content of the atmosphere as a result of inerting the space below the tank bottom.

11.3.2.1.4 Flammable and toxic vapors may be produced by the application of heat and testing or monitoring instruments may not detect the presence of flammable or toxic vapors until hot work commences.

11.3.2.1.5 Toxic atmospheres may originate from welding fumes or from the material on which hot work is being performed.

11.3.2.1.6 The tank may have been painted with lead-based paint on the outside and/or coated on the inside with an epoxy or special material to prevent corrosion, any of which will create toxic vapors or fumes upon being heated.

11.3.2.1.7 An oxygen-enriched atmosphere may be created inside the tank from leaking hoses, torches, or cylinder valves when using oxy/acetylene/propane burning equipment.

11.3.2.1.8 Conditions may occur outside the tank that will require all hot work to stop and workers to exit the tank.

11.3.3 Equipment Hazards

The entry supervisor shall be aware of potential hazards associated with the use of hot work equipment and shall:

1) prohibit oxygen, flammable gas and inert gas cylinders from being taken into tanks classified as permit required or non-permit required confined spaces and non-confined spaces;

2) require that workers disconnect hoses and torches associated with oxygen and gas cylinders during extended work break period (exceeding 1 hour) and when leaving the vicinity of the tank, and disconnect and remove cylinders from the tank area at the end of the work shift;

3) assure that electrical welding equipment is approved for use in the tank, intrinsically safe, inspected before and during use and properly grounded (earthed).

11.4 Hot Work In Leaded Service Tanks

11.4.1 General

Hot work permits shall not be written until a tank that has been in leaded service has been tested and declared lead-in-air free.

11.4.2 Hot Work Permit

The entry supervisor shall:

11.4.2.1 Require surfaces of tanks that have been in leaded service to be cleaned, scraped or wire brushed.

11.4.2.2 Require that bare metal covers an area at least 12 in. (30 cm) surrounding any area that may be subject to excessive heat from hot work.

11.4.2.3 Determine the appropriate protective clothing, gloves, face shield or goggles and respiratory protection, if required, to be worn by entrants and workers performing scraping, wire brushing and hot work.

11.4.2.4 Consider the potential for organic lead vapors to be released from rust, residue and deposits and require workers to use appropriate respiratory protection during cleaning and hot work.

11.4.2.5 As an alternative to cleaning surfaces down to bare metal, the qualified person issuing the permit may require workers to use appropriate approved supplied-air respiratory equipment when conducting hot work on unclean surfaces.

11.5 Fire Prevention

11.5.1 General

When hot work is permitted inside or around the outside of a tank, entry supervisors shall determine and indicate the required fire protection equipment on the entry and hot work permits. Incipient first aid fire protection equipment, including, but not limited to, charged fire extinguishers and/or pressured fire hoses, shall be in working order and available inside and/or outside the tank, as specified on the permit.

11.5.2 Employee Use of Equipment

Employers shall assure that employees are instructed in the use of the incipient fire protection equipment provided.

12 Emergency Planning

12.1 Emergency Response Plan

12.1.1 General

Employers shall develop and implement an emergency response plan that includes procedures for rescue of entrants in the event that an emergency occurs.

12.1.2 Plan Elements

12.1.1.1 The plan shall consider emergencies involving hazardous and toxic exposures in excess of permit limits, injury or illness, entrapment, fires and explosions, flammable and toxic liquid, vapor or gas releases, and other emergencies from sources external and internal to the tank.

12.1.1.2 The plan shall be tank specific and include procedures for summoning rescuers and other emergency responders and conducting rescue of entrants from tanks that are classified as permit required and non-permit required confined spaces.

12.1.1.3 The plan shall identify the parties responsible for rescue activities. Rescuers may be:

1) designated employees or attendants who are trained and equipped for rescue activities.

2) facility emergency response brigade;

3) designated and qualified outside rescue service;

4) workers capable of self-rescue.

12.1.3 Employer Responsibilities

Employers shall ensure that workers know the procedure and have a means of communication to summon assistance in event of an emergency. Employers shall designate conditions where entrants should be capable of performing self-rescue depending on the configuration of the tank, work performed, route and ease of egress, exposure hazards, and other appropriate factors.

12.1.4 Worker Responsibilities

Workers shall be aware of:

a) their responsibility to immediately stop work and vacate the tank and/or evacuate the area upon indication or notification of an emergency;

b) emergency procedures;

c) know how to use the provided means of communication to summon assistance in event of an emergency;

d) their capability for self-rescue depending on the configuration of the tank, work performed, route and ease of egress, exposure hazards, and other appropriate factors.

12.2 Outside Rescue Services

12.2.1 Evaluation of Rescue Service

Employers shall evaluate the ability of prospective outside rescue services to respond to an emergency in a timely manner considering the potential hazards, exposures, work operations, and the specific tank involved.

12.2.2 Selection of Rescue Service

Employers shall base their selection of a specific rescuer on criteria, including:

1) the rescue service’s experience, equipment and capability;

2) the rescue service's proficiency with tank rescue related tasks and use of equipment;

3) the rescue service's training and ability to function appropriately during rescue activities;

4) the qualifications and capability of its personnel and its ability to reach the entrants within a time frame appropriate to the identified hazards and potential emergency situations.

12.2.3 Employer Requirements

Employers shall provide the designated rescue service with:

12.2.3.1 Appropriate information–about the potential atmospheric and physical hazards to be expected during a rescue, including copies of SDSs and other relevant information.

12.2.3.2 Access to the site and the specific tank to be entered so that the rescuers can prepare emergency plans and conduct practice rescue operations prior to the start of the tank cleaning operations.

12.3 Employer Rescuers

12.3.1 In lieu of relying upon outside rescue services, employers, owners/operators, or tank contractors may designate an on-site trained and qualified facility emergency response brigade to be responsible to respond to emergencies and conduct rescue operations. The specific duties of designated owner/operator responders, contractor rescuers, and outside rescue services shall be established during the tank pre-cleaning meeting and/or significant phase of tank work.

12.3.2 Owners/operators and tank contractors providing rescue services shall comply with the following.

12.3.2.1 Train and qualify responders in general rescue and confined space entry. Documentation of responder proficiency shall be maintained in accordance with the training requirements of this standard.

12.3.2.2 Train responders in basic first aid and cardiopulmonary resuscitation (CPR) and ensure that at least one responding rescuer is currently certified in CPR and first aid.

12.3.2.3 Provide appropriate personal protective clothing, respiratory protection and rescue equipment required for tank rescue and entry and train responders in its use.

12.3.2.4 Inform responders of potential atmospheric and physical hazards to be expected during a rescue, including copies of SDSs and other relevant information.

12.3.2.5 Ensure access to the tank so responders can pre-plan rescue operations.

12.3.2.6 Ensure that facility emergency response brigades practice confined space rescues at least once every 12 months using simulated operations in which dummies, mannequins or persons are removed from actual tanks or confined spaces representative of the types of tanks to be cleaned.

12.3.2.7 Ensure that responders are aware of the potential hazards of removing an entrant from a tank by use of the retrieval line from outside the tank and take appropriate precautions.

12.4 Rescue Equipment

12.4.1 General

To facilitate non-entry rescue into a tank classified as a permit-required confined space, entry supervisors shall require that entrants use appropriate retrieval systems or methods (unless the use of such equipment increases the

overall risk of entry or impedes the rescue of the entrant). The type and use of retrieval systems or methods shall be evaluated by entry supervisors in accordance with the potential hazards, rescue difficulties, and levels of precaution in this standard and applicable government regulations.

12.4.2 Retrieval Equipment

12.4.2.1 When retrieval equipment is required, employers shall provide approved retrieval systems and equipment meeting applicable government requirements (in the United States, OSHA 29 *CFR* 1910.146) or industry standards. Retrieval systems shall include the following, as applicable.

12.4.2.1.1 Chest or full body harness with a retrieval line attached at the center of the entrant's back near shoulder level, above the entrant's head or at another point that presents a small enough body profile to facilitate rescue.

12.4.2.1.2 Wristlets, that may be used in lieu of chest or body harnesses (except for vertical pulls), if demonstrated to be more effective or if the use of harnesses is infeasible for the tank to be entered.

12.4.2.1.3 A retrieval line, the end of which is attached to a mechanical device or fixed point outside the tank so that rescue can begin as soon as necessary. The mechanical device shall be capable of retrieving entrants from vertical spaces more than 5 ft (1.5 m) in depth.

12.4.3 Special Equipment

12.4.3.1 Employers and entry supervisors shall recognize the potential hazards involved with descent upon floating roofs of tanks in service or when entry into a tank is through an opening in the roof of the tank. Designated outside rescue services, owner/operator responders, or contractor rescuers shall provide the special rescue equipment needed when descent is made onto floating roofs of tanks in service, including the following.

12.4.3.1.1 A rescue toboggan, capable of lifting an incapacitated person out of the tank, that fits through the roof opening. Where required, a davit shall be provided at the roof opening to assist in lifting the toboggan out of the tank.

12.4.3.1.2 Appropriate harness safety belts, harnesses, and/or lifelines to be worn by entrants and rescuers. A mechanical device or fixed point shall be provided outside the tank that is able to retrieve entrants from vertical spaces more than 5 ft (1.5 m) in depth.

12.4.3.1.3 Lightweight material that can be lowered onto the floating roof to provide a walking surface.

12.5 Other Emergencies

Employers shall ensure that their emergency plans address other potential tank work related incidents in addition to rescue of entrants, including, but not limited to, fires, explosions, spills, releases of liquids, vapors and toxic substances, and emergencies elsewhere inside or outside the facility that could impact on tank cleaning operations.

12.6 Medical Emergencies

12.6.1 General

Employers shall develop plans for medical emergencies similar to those for rescue, fire, and other emergencies.

12.6.2 Medical Information

Where the potential exists for any worker who is injured or taken ill during tank cleaning/entry operations to be exposed to a hazardous or toxic substance, employers shall assure that copies of SDSs and similar written information about the product and material being handled that are required to be kept at the work site, are made available to the medical facility treating the employee.

12.6.3 Medical Facilities

Employers shall determine a primary (and if necessary a secondary) emergency medical care facility and meet with the staff and medical emergency response personnel to assure that reasonable care for potential exposures, illnesses, and injuries can be provided.

13 Return To Service

13.1 General

13.1.1 Plans and Procedures

Employers shall develop and implement plans and procedures returning the tank to service similar to those used to remove the tank from service.

13.1.2 Regulatory Requirements

13.1.2.1 Employers shall review applicable government regulations; industry standards and facility policy to determine what inspection, testing, record keeping and reporting is required when returning a tank to service.

13.1.2.2 If major repair, alteration or reconstruction work was performed, employers shall ensure that testing, inspection and certification requirements have been satisfactorily completed to ensure the mechanical and physical integrity of the tank prior to returning the tank to service.

13.1.2.3 Regulatory requirements prior to returning the tank to service may include hydrostatic testing, seal inspection and visual inspection for leakage.

13.1.2.4 Where tank inspection is required for environmental or other compliance, prior to returning the tank to service, the owner/operator shall notify the appropriate regulatory agencies.

13.2 Preparation

13.2.1 General

The employer shall assure that operations elsewhere in the facility do not subject any part of the return to service process to hazardous conditions.

13.2.2 Tank Inspection and Closing

Employers shall designate a qualified person to thoroughly inspect the tank prior to the reinstallation of tank opening (manway) covers. The qualified person shall:

1) verify that all entrants and workers have exited the tank;

2) verify that all tank cleaning repair and maintenance equipment, tools, materials and debris have been removed from inside the tank;

3) verify that all internal connections and appurtenances have been reconnected or attached;

4) ensure that the tank inspection and verification results are entered on the entry permit;

5) ensure that floating roof seals are in good working order;

6) conduct a visual inspection for integrity-related issues including tank bottom lining damage, damp spots, mechanical damage, etc. that may have been caused by tank work or missed in previous inspections.

13.2.3 Reactivating Isolated Equipment

13.2.3.1 Employers shall assign qualified persons to reactivate all equipment, piping and appurtenances that were deactivated or isolated when the tank was decommissioned.

13.2.3.1.1 Employers shall assure that equipment is reactivated in a manner that will not create any safety hazards and adverse conditions at the tank or elsewhere in the facility.

13.2.3.1.2 Employers shall provide new approved gaskets, flanges and bolts for reconnecting piping, equipment and tank opening (manhole) covers.

13.3 Refilling Tanks

13.3.1 General

Employers shall assign qualified persons to conduct visual examinations or use other equivalent methods to inspect the tank and check for leakage upon initiation of filling and periodically throughout the filling operation, until the tank has reached operating capacity. Should leaks occur, the qualified persons shall immediately notify the employers so that product receipt can be stopped. The emergency plan shall be activated in event of a major leak, large spill, or release of flammable or toxic vapors.

13.3.2 Initial Fill Rate

Employers shall develop and implement safe operating procedures for filling empty tanks. The flow rate (velocity) of product in the tank fill line (no credit may be taken for diffusers) shall be controlled in accordance with API 2003 until the inlet opening of the fill line is covered with liquid, to minimize the creation of static electricity.

13.3.3 Filling Floating Roof Tanks

Employers shall develop and implement safe operating procedures for filling tanks until the floating roof is floating. The flow rate (velocity) of product in the fill line (no credit may be taken for diffusers) shall be controlled in accordance with API 2003 until the floating roof is floating. Additional velocity restrictions may be required by the floating roof manufacturer.

13.3.4 Heating Coil Status During Filling Operations

Employers shall develop and implement safe operating procedures for operation of heating coils to prevent operation until fully submerged. A minimum product level where heating coils may be operated shall be defined.

13.3.5 Mixer Status During Filling Operations

Employers shall develop and implement safe operating procedures for operation of mixers. A minimum product level where mixers may be operated shall be defined.

13.4 Sampling and Gauging Tanks

13.4.1 Requirements

13.4.1.1 Employers shall develop and implement safe operating procedures for sampling and gauging tanks after returning the tank to service in accordance with API 2003; including the following.

13.4.1.1.1 Employers shall assure that employees do not conduct sampling or hand gauging until tank filling operations are completed and the tank has had time to relax in order to dissipate any static charges and vapors generated during the filling operation. (See API 2003 and ISGOTT for additional information regarding relaxation time.)

13.4.1.1.2 Employers shall assure that workers do not go onto the top of any internal, covered open top or open top floating roof on a flammable liquid tank for the minimum period of time specified in API 2026 after filling operations are completed or when the floating roof is not floating. Access/egress to/from floating roofs shall be in accordance with API 2026.

13.4.1.1.3 Employers shall assure that gauging and sampling operations are not performed when a lightning storm is imminent or in progress.

13.4.2 Testing

13.4.2.1 Testing shall be conducted in accordance with API 2026 to ensure that the oxygen level is within prescribed limits, vapor or gas concentration in the atmosphere above the floating roof is 10% LEL or less and that any exposure to toxic hazards is within acceptable permit limits before any employee is permitted to enter upon floating roofs to conduct gauging or sampling.

13.4.2.2 Entry upon a covered open-top floating roof or an internal floating roof shall require the issuance of an entry permit.

13.4.2.3 Entry upon an open-top floating roof shall also require an entry permit when the roof level is more than 5 feet below the top of the tank.

13.5 Control of Ignition Sources

During tank filling operations, flammable vapor may be expelled from the vents, relief devices, and other tank openings. In addition, leaks, overflows, ruptures, and spills may occur. Employers shall establish and implement procedures to control tank filling operations during lightning storms and to prohibit other sources of ignition in the vicinity of the tank during tank refilling, except under hot work permit requirements.

14 Training

14.1 General

Employers shall assure that all entry supervisors, entrants, bottle watches, attendants and qualified persons including, but not limited to, permit issuers, testers, standby persons, rescuers, tank operators and tank cleaning workers, are trained, educated or experienced, as required by this standard and applicable government regulations.

14.2 Training Requirements

Employers shall assure that employees have been trained or educated and retrained or re-educated, as follows:

1) prior to beginning the initial assignment to their work or duties;

2) before a change in assignment to a different type of work or duties;

3) whenever there is a change in operations, procedures or requirements that has the potential to present a hazard for which the employee has not been previously trained or educated;

4) whenever the employer has reason to believe the employee requires retraining or additional education due to inadequacies in the employee’s knowledge or skill or because the employee deviates from the confined space program or established tank cleaning procedures.

14.3 Training Verification

Employers shall verify, in writing, that employees have been trained, as required, and the verification shall be available for inspection by employees and their designated representatives. The verification shall contain the names of the employees trained, the training subject, the signature, name or initials of the trainer(s), and the date(s) the training was conducted.

14.4 Qualification

Employers shall assure that all employees engaged in tank work have the understanding, knowledge, and skills and are able to safely perform their assigned duties.

Bibliography

United States Government Regulations

The following United States government regulations and publications provide information related to safe entry and cleaning of petroleum storage tanks in the United States. Although this standard is intended to be consistent with applicable laws and regulations in effect at the time of publication, the most recent edition of each code, standard or publication that is applicable, should be consulted, as appropriate, to assure compliance.

[1] DOT 49 *CFR* [6], Title 49, Parts 171–180; Subchapter C, "Hazardous Materials Regulations"

[2] EPA 40 *CFR* [7], Title 40, Parts 260–271

[3] NIOSH 2533 [8], *Manual of Analytical Methods*, *Criteria for a Recommended Standard for Working in Confined Spaces*

[4] OSHA 29 *CFR* 1910.38 [9], *Emergency Action Plans*

[5] OSHA 29 *CFR* 1910.39, *Fire Prevention Plans*

[6] OSHA 29 *CFR* 1910.95, *Occupational Noise Exposure*

[7] OSHA 29 *CFR* 1910.106, *Flammable and Combustible Liquids*

[8] OSHA 29 *CFR* 1910.120, *Hazardous Waste Operations and Emergency Response*

[9] OSHA 29 *CFR* 1910, *Subpart I, Personal Protective Equipment*

[10] OSHA 29 *CFR* 1910.134, *Respiratory Protection*

[11] OSHA 29 *CFR* 1910.146, *Permit-required Confined Spaces*

[12] OSHA 29 *CFR* 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*

[13] OSHA 29 *CFR* 1910, *Subpart Q, Welding, Cutting and Brazing*

[14] OSHA 29 *CFR* 1910, *Subpart Z, Toxic and Hazardous Substances*

[15] OSHA 29 *CFR* 1910.1025, *Lead*

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6 Department of Transportation. The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, D.C. 20402. www.gpoaccess.gov.

7 U.S. Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, Washington, DC 20460, www.epa.gov.

8 National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention (CDC), NIOSH/CDC, Education and Information Division, 4676 Columbia Parkway, Cincinnati, Ohio 45226, www.cdc.gov/niosh. Searchable on-line at http://www.cdc.gov/niosh/npg/npg.html, or order from http://wwwn.cdc.gov/pubs/niosh.aspx#2008 Publications.

9 U.S. Department of Labor, Occupational Safety and Health Administration, 200 Constitution Avenue, NW, Washington, DC 20210, www.osha.gov.

[16] OSHA 29 *CFR* 1910.1028, *Benzene*

[17] OSHA 29 *CFR* 1910.1200, *Hazard Communication*

[18] OSHA 29 *CFR* 1926.62, *Lead*

Other Publications and References

[19] "Confined Space Safe Practices, Parts I and II"; Guy R. Colonna, Lamar Labauve, and Mike Roop; National Fire Protection Association, Quincy, MA, Nov., 1999.

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