Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

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FOREWORD

ANSI/API Standard 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, was prepared under the auspices of the API Safety and Fire Protection Subcommittee. It is intended for use by API member companies and others to develop safe practices for planning, managing, and conducting tank cleaning work in atmospheric and low pressure storage tanks. A companion document, ANSI/API Recommended Practice 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, provides supplemental information applicable to the requirements and components of this standard.

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Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

1 General

1.1 SCOPE AND APPLICABILITY

This standard is applicable to cleaning 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, refineries, petrochemical plants, bulk plants and terminals. This standard provides requirements for safely planning, coordinating and conducting tank cleaning operations from decommissioning (removal from service) through recommissioning (return to service) tanks that have contained flammable or combustible liquids or petroleum related toxic materials. This standard does not and cannot cover every possible unique hazard or situation that may arise during tank cleaning operations. These site specific, product specific and tank specific hazards and situations must be addressed by employers (owner/operators or contractors) using the appropriate principles and considerations provided for by this standard. The ANSI/API Recommended Practice 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, provides supplemental information applicable to the requirements of 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 ANSI/API Standard 2015 is not intended to cover non-atmospheric and non-low pressure tanks and vessels, many of the safe tank cleaning and entry principles and requirements in this standard would be applicable. Using the information provided in ANSI/API Standard 2015 and in ANSI/API Recommended Practice 2016, together with appropriate government regulations, industry standards, and other applicable requirements, employers (owners/operators and contractors) shall develop site and tank, potential hazard and project specific guidelines and procedures to ensure that the tanks and vessels not covered by this standard are safely decommissioned, cleaned, and re-commissioned.

1.3 ANSI/API RECOMMENDED PRACTICE 2016

ANSI/API Recommended Practice 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, provides guidance and additional information on specific aspects of tank cleaning preparation, hazard awareness, decommissioning, emptying, isolating, vapor and gas freeing, degassing, ventilating, atmospheric testing, inspecting, cleaning, entry, safe (cold) work, hot work, and recommissioning operations.

ANSI/API Recommended Practice 2016 contains the following sections:

1. Petroleum Storage Tank Hazards
2. Vapor and Gas Freeing, Degassing, and Ventilating Tanks
3. Removing Sludge and Residue from Tanks
4. Unique Tanks
5. Specific Hazardous Substances
6. Control of Ignition Sources
7. Tank Cleaning Checklist
8. Oxygen, Combustible Gas and Toxic Substance Instruments
9. Floating Roof Hazards Associated with Tank Cleaning

1.4 REGULATORY REQUIREMENTS

In addition to the requirements contained in this standard, employers (owners/operators and contractors) 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, "General Industry," and Part 1926, "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 function as a substitute for applicable regulations, codes, standards or employer (owner/operator and contractor) safe (cold) work and hot work practices and procedures, all of which must be reviewed in their entirety to determine their applicability to the facility, its location, the tanks involved and the proposed work.

1.5 TANK CLEANING OVERVIEW

There are a number of basic activities applicable to every tank that is to be cleaned. These activities include, but are not limited to, confined space classification; decommissioning; product, sludge and residue removal; isolation; vapor and gas freeing, degassing and ventilation; entry; tank cleaning; atmospheric testing; inspection; rescue; hot and safe (cold) work operations; and recommissioning. Many of these activities are covered by existing employer programs and procedures such as Confined Space; Energy Isolation; Hot Work and Safe Work; Hazard Communications; Operations, Maintenance and Inspection; Respiratory Protection and Process Safety Hazard Analysis.

ANSI/API Recommended Practice 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, is intended to assist employers (owners/operators and contractors) in developing plans and conducting safe tank cleaning operations in accordance with the requirements of this standard, by providing supplementary information covering the following elements.

1.5.1 Tank Pre-Cleaning Elements

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

b. Determining that tank cleaning supervisors, entrants, testers, attendants, standby persons, rescuers and workers are trained, educated and/or otherwise qualified to perform assigned tasks, including but not limited to, hazard evaluation, testing, permit issuance, entry, tank cleaning, attendant, standby, rescue, and inspection activities.

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

d. Establishing requirements, exposure limits and procedures for atmospheric testing and determining, achieving and maintaining safe exposure levels for oxygen, flammable vapors and toxic materials including, but not limited to, hydrogen sulfide, benzene and organic lead.

e. Determining the need for and obtaining required regulatory permits.

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. Establishing a confined space identification and classification program and procedures, and identifying 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 and implementing a hot work, safe (cold) work and entry permit program and establishing requirements and responsibilities for permit issuance and cancellation.

j. Determining personal and respiratory protection requirements.

k. Determining specific work to be performed and assigning responsibilities.

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

1.5.2 Tank Cleaning Elements

a. Establishing requirements and procedures for entry onto floating roofs, inspecting roofs for stability and inspecting and setting legs.

b. Establishing requirements and procedures for removal of recoverable product and for removal, handling, storage, and disposal of sludge and residue (hazardous waste).

c. Determining the required tank cleaning equipment.

d. Identifying and establishing procedures for controlling potential ignition sources in the area including hot work, grounding and bonding, approved electrically driven equipment, internal combustion engines, low voltage lighting, and intrinsically safe communication devices.

e. Establishing requirements and procedures for safe tank cleaning including, but not limited to, vacuum truck operations and use of pumps, eductors/blowers, degassing, and tank cleaning equipment.

f. Establishing normal and emergency communication and notification procedures.

g. Determining rescue requirements, designating rescuers, determining required rescue equipment, and establishing and implementing an emergency response and rescue plan.

h. Establishing requirements and procedures for tank isolation including, but not limited to, valves, connections, lines, drains, water draws, impellers, agitators, heating coils, mechanical and electrical appurtenances, etc.

i. Establishing requirements, equipment, and procedures for vapor and gas freeing, degassing, and ventilation and establishing procedures for inerting, if required.

j. Determining the requirements and conditions for continuous or periodic flammable vapor and toxic exposure monitoring and continued mechanical ventilation during entry and work.

k. Establishing cleaning, inspection and testing procedures to assure the tank, double walls and bottoms, roofs, internal lines, pontoons, floating rood supports, columns, sumps, etc. are completely free of liquid, vapors, gases, and contaminants after cleaning, including hazards arising from acids or chemicals used in treating or cleaning tanks.

l. Establishing procedures to assure that any tank that is classified as either a permit required or a non-permit required confined space is not left open and unattended.

m. Establishing procedures for conducting hot work inside and on top of cleaned tanks.

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

o. Establishing requirements and procedures for the 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.

p. Establishing requirements and procedures for 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.

1.5.3 Tank Post-Cleaning Elements

a. Establishing requirements and procedures for returning tanks to service including inspections and safety checks to assure that the tank is clean, free of waste and debris, and ready for recommissioning.

b. Establishing requirements and procedures for checking the tank and lines during refilling for leaks and to prevent overfilling the tank.

c. Establishing requirements and procedures for 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 review and adjusting procedures as necessary.

2 References

2.1 CODES, STANDARDS AND RELATED PUBLICATIONS

The following industry and consensus standards, codes, and publications referenced herein provide information related to safe entry and cleaning of petroleum storage tanks. While this ANSI/API standard is intended to be consistent with applicable codes and standards 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.

API

Bull E2	*Bulletin on Management of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Production*
Std. 650	*Welded Steel Tanks for Oil Storage*
Std 653	*Tank Inspection, Repair, Alteration and Reconstruction*
RP 2003	*Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents*
Publ 2009	*Safe Welding & Cutting Practices in Refineries, Gas Plants & Petrochemical Plants*
RP 2016	*Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*
Publ 2026	*Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service*
Publ 2027	*Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*
Publ 2202	*Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks*
Publ 2207	*Preparing Tank Bottoms for Hot Work*
Publ 2217A	*Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*
Publ 2219	*Safe Operating Guidelines for Vacuum Trucks in Petroleum Service*
RP 2220	*Improving Owner and Contractor Safety Performance*

ACGIH[1]

Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices and Documentation

[1]American Conference of Governmental Industrial Hygienists, Kemper Meadow Center, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.

ANSI[2]

Z49.1	*Safety in Welding and Cutting*
Z88.1	*Respiratory Protection*
Z117.1	*Safety Requirements for Confined Spaces*

CGA[3]

G-7.1	*Commodity Specification for Breathing Air*

International Chamber of Shipping, International Association of Ports and Harbors, and the Oil Companies International Marine Forum[4]

ISGOTT	*International Safety Guide for Oil Tankers and Terminals*

NFPA[5]

	Fire Protection Handbook
30	*Flammable and Combustible Liquids*
51B	*Cutting and Welding Processes*
70	*National Electrical Code*
77	*Static Electricity*
326	*Safeguarding of Tanks and Containers for Entry, Cleaning or Repair*

2.2 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.

NIOSH[6]

2533	*Manual of Analytical Methods*
—	*Criteria for a Recommended Standard for Working in Confined Spaces*

[2]American National Standards Institute, 25 West 43rd Street, New York, NY 10036.
[3]Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, Virginia 22202-4102.
[4]International Chamber of Shipping, International Association of Ports and Harbors, and the Oil Companies International Marine Forum, Portland House, Stag Place, London SW1E SBH, England.
[5]National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269.
[6]National Institute of Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45226

OSHA[7]

29 CFR 1910.38	*Employee Emergency Plans and Fire Prevention Plans*
29 CFR 1910.95	*Noise*
29 CFR 1910.106	*Flammable and Combustible Liquids*
29 CFR 1910.120	*Hazardous Waste Operations and Emergency Response*
29 CFR 1910	*Subpart I, Personal Protective Equipment*
29 CFR 1910.134	*Respiratory Protection*
29 CFR 1910.146	*Permit-required Confined Spaces*
29 CFR 1910.147	*The Control of Hazardous Energy*
29 CFR 1910.251	*Subpart Q, Welding, Cutting and Brazing*
29 CFR 1910.1000	*Subpart Z, Toxic and Hazardous Substances (PELs)*
29 CFR 1910.1025	*Lead*
29 CFR 1910.1028	*Benzene*
29 CFR 1910.1200	*Hazard Communication*
29 CFR 1926.62	*Lead Exposure, Construction Industry*

DOT[8]

49 CFR	*Code of Federal Regulations*, Title 49, Parts 171–180; Subchapter C, "Hazardous Materials Regulations"

EPA[9]

40 CFR	*Code of Federal Regulations*, Title 40, Parts 260–271

2.3 OTHER PUBLICATIONS AND REFERENCES

2.3.1 "The Hazard of Lead Absorption Associated with the Cleaning and Repair of Gasoline Storage Tanks," Ethyl Corporation, Richmond, VA, March, 1971.

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

[7]Occupational Safety and Health Administration, U.S. Department of Labor, Washington, D.C. 20402
[8]U.S. Department of Transportation, available from the U.S. Government Printing Office, Washington, D.C. 20402.
[9]U.S. Environmental Protection Agency, available from the U.S. Government Printing Office, Washington, D.C. 20402.

2.3.3 "Tank Degassing Texas Style," HMT Tank Service, Beaumont, TX.

2.3.4 "Tank Cleaning Principles," Philip E Myers, Chevron Corp., San Ramon, CA. Paper presented at 7th Annual Aboveground Storage Tank Conference, Houston, TX, Nov, 1995.

2.3.5 "OSHA Confined-Space Regs Interpreted for Storage Tank Operations," Philip E. Myers, Chevron Corp, San Ramon, CA; *Oil and Gas Journal*, Feb. 1994.

3 Definitions

3.1 GENERAL

The following definitions are applicable to tank cleaning operations as described in this standard.

3.2 DEFINITIONS

3.2.1 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.

3.2.2 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 (owner/operator and contractor) permit required confined space program. Attendants may also perform the duties of standby personnel when entrants use respiratory protective equipment.

3.2.3 blanking: The absolute closure of a pipe or line by fastening a solid, flat plate (designed to retain the pressure of the pipeline), between two flanges, using two gaskets and fully engaged bolts or stud bolts in all flange bolt-holes. Blanks have handles extending beyond the flange with a $^1/_4$-inch (6.3 mm) minimum hole in the handles (see ASME B 31.3 for additional information).

3.2.4 blinding: The absolute closure of the open end of a pipe, line or pressure vessel opening by fastening a solid, flat plate (designed to retain the pressure) across the opening, using a gasket and fully engaged bolts or stud bolts in all flange bolt-holes (see ASME B 16.5 and B 16.47 for additional information).

3.2.5 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.

3.2.6 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.).

3.2.7 combustible gas indicator: An instrument used to sample the atmosphere to indicate if any flammable (combustible) vapors/gases are present, determine the composition of hydrocarbon gas and air mixtures and indicate the concentration of vapor/gas present in the atmosphere as a percentage of the lower explosive (flammable) limit.

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

3.2.9 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.

3.2.9.1 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 four 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 floors that slope downward, tapering to smaller cross-sections.
- Contains any other recognized serious safety or health hazard.

3.2.9.2 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.

3.2.9.3 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.

3.2.10 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.

3.2.11 double block and bleed: The positive closure of a line or 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.

3.2.12 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*.

3.2.12.1 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 conditions.
- 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.

3.2.12.2 Group D location: A division classified location wherein any of the following conditions apply:

- A specific level of protection that 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.

3.2.12.3 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).

3.2.13 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.

3.2.13.1 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.

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

- A location where ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions.
- A location where ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage.
- A location where 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.
- A location that is 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.

3.2.14 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 entrants or negatively impact on the tank cleaning operation.

3.2.15 employer: An owner, operator, contractor, or subcontractor whose respective employees are performing a task or activity described in this standard.

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

3.2.15.2 contractor: A company or person selected and hired by the owner/operator to conduct tank cleaning 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.

3.2.15.3 sub-contractor: A company or person selected and hired by a contractor to conduct specific tank cleaning 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.

3.2.16 empty: A tank that has no (standing) product remaining in the tank and is ready for cleaning.

3.2.17 engulfment: The surrounding and effective entrapment of an entrant by a liquid or finely divided (flowable) 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.

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

3.2.19 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.

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

3.2.21 entry supervisor: The qualified person (employee, foreman, supervisor, crew chief, etc.) designated by the employer (owner/operator and contractor) to be responsible for determining the requirements and whether or not acceptable entry conditions exist at permit required confined spaces and non-permit required confined spaces, where entry is contemplated. Entry supervisors shall authorize entry, oversee entry operations and terminate entry as required by the permit or conditions. An entry supervisor, who is properly qualified, trained and equipped, may serve as an attendant or as an entrant. The duties of entry supervisor may be passed from one entry supervisor to another entry supervisor, during the course of an entry operation.

3.2.22 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.

3.2.22.1 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."

3.2.22.2 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."

3.2.23 fixed (cone) roof tank: A tank with a self-supporting external fixed (cone) roof with or without internal support columns.

Note: Larger diameter fixed (cone) roofs may have internal supports.

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

3.2.25 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. A gas can be changed to a liquid only by the combined effect of increased pressure and decreased temperature. In this standard, for tank cleaning purposes, *flammable gas* shall be considered the same as *flammable vapor.*

3.2.26 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. Under normal ambient temperatures, Class IA and Class IB liquids generate sufficient vapors to create flammable vapor concentrations at all times. Vapors from flammable and combustible liquids are heavier than air.

3.2.27 flammable vapor indicator: See *combustible gas indicator.*

3.2.28 floating roof tank: Any aboveground, vertical atmospheric storage vessel with an internal or external floating roof. The types of floating roof tanks are as follows:

3.2.28.1 open-top (external) floating roof tank: A tank with an uncovered roof that floats on the surface of the liquid contained inside the tank (except when empty).

3.2.28.2 covered open-top floating roof tank: An open-top (external) floating roof tank that has been provided or equipped with a permanently attached cover (geodesic dome or similar weather protection) over the top of the tank.

3.2.28.3 internal floating roof tank: A tank that has a fixed (cone) roof over the top of the tank and an internal floating deck or cover that rests on the surface of the liquid inside the tank (except when empty).

3.2.29 gas freeing: See *vapor freeing.*

3.2.30 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 permit required 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 exceed 80% of its LEL.
- Atmospheric oxygen concentration different from ambient. An oxygen level below 19.5% signifies an oxygen deficiency and a level above 23.5% signifies an excess of oxygen.
- Atmospheric concentration of any substance for which a dose or permissible exposure limit is published in applicable government regulations, Material Safety Data Sheets, standards or other publications or internal documents, and could result in employee exposure in excess of the substance's dose or permissible exposure limit (PEL).
- Any other atmospheric condition immediately dangerous to life or health (IDLH).

3.2.31 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.

3.2.32 hot work: Any work that has the potential to produce enough thermal energy to provide an ignition source in an area where a potential exists for a flammable gas or vapor-in-air atmosphere in the explosive (flammable) range to occur.

3.2.33 hot work permit: The employer's (owner/operator and contractor) written authorization to perform hot work operations or use equipment (including, but not limited to, open flames, welding, cutting, grinding, burning, heating, use of internal combustion engines and non-explosion proof electric motors) capable of producing a source of ignition.

3.2.34 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 permit required confined space. For example, an oxygen deficient atmosphere is considered IDLH. Some toxic materials, such as hydrogen fluoride gas and cadmium vapor, may produce immediate transient effects that even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12 to 72 hours after exposure. The exposed worker "feels normal" from recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health (IDLH). Other toxic substances, such as hydrogen sulfide, immediately desensitize a person so that continued exposure is no longer noticed. Certain irritation effects may also impede the entrant's ability to escape permit required confined spaces.

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

CAUTION: Use of inert gas or flue gas creates an IDLH oxygen deficient atmosphere).

3.2.36 instruments: The oxygen monitors, combustible gas indicators and toxic substance analyzers (measuring equipment) used to test (or sample) atmospheric conditions and determine, indicate, measure and monitor the amount of oxygen in the atmosphere and presence of hazardous substances, including percentage of flammable gas or vapor-in-air and concentrations of toxic substances.

3.2.37 isolation: The process by which a permit required confined space or non-permit confined space is removed from service (decommissioned) and completely protected against the release of energy or material into the space. Isolation includes, but is not limited to, blanking or blinding; breaking, misalignment of, opening or removing sections of lines or pipes; using a double block and bleed system; lock-out or tag-out of all sources of energy; locking, sealing, and tagging all valves; and blocking and disconnecting all mechanical linkages.

3.2.38 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 0.075 milligrams of organic lead per cubic meter (2 micrograms of organic lead per cubic foot).

3.2.39 lockout/tagout: The condition when electrical, hydraulic and mechanical switches are open in the de-energized position and locked out and/or mechanical linkages are set, tagged and sealed or locked out to preclude the input of product or energy into a permit required confined space, non-permit confined space or non-confined space. Where required by regulation or employer procedures, the system shall be tested to assure isolation.

3.2.40 material safety data sheet (MSDS): Written or printed material prepared in accordance with applicable regulations and standards (for example, OSHA 29 CFR 1910.1200) concerning hazardous chemicals. MSDSs pro-

vide physical properties, safety, fire prevention and protection, personal protection, and health data.

3.2.41 may: Is used in this standard to provide information on procedures and practices that are optional (see "shall" and "should").

3.2.42 non-confined space: See *confined space.*

3.2.43 oxygen deficient atmosphere: An atmosphere containing less than 19.5 percent oxygen by volume.

3.2.44 oxygen enriched atmosphere: An atmosphere containing more than 23.5 percent oxygen by volume.

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

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

3.2.47 permissible exposure limit (PEL): U.S. Department of Labor, OSHA's designated limit of exposure to any airborne contaminant to which an employee may be subjected. The PEL may be expressed as an 8-hour time-weighted average, a ceiling value, a short-term exposure limit or a skin exposure designation.

3.2.48 permit program: The employer's (owner/operator and contractor) overall program for controlling and regulating safe (cold) work, hot work and entry into permit required confined spaces, to protect entrants from permit required confined space hazards and, where appropriate, to control employees access to and entry into permit required confined spaces.

3.2.49 permit system: The employer's (owner/operator and contractor) written procedure for preparing and issuing permits for entry, hot work and cold (safe) work. The employer's (owner/operator and contractor) written procedure for preparing and issuing permits for entry into permit required confined spaces shall include the safety and health related requirements for issuance of the permit, conditions for canceling or suspending the permit and requirements for safeguarding or returning the space to service following termination of entry.

3.2.50 product: The liquid petroleum hydrocarbon or other material stored in tanks.

3.2.50.1 recoverable product: Usable product removed from the tank and returned to storage.

3.2.50.2 non-recoverable product: Non-usable product removed from the tank that needs further treatment in order to be usable product or requires disposal.

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

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

3.2.53 purging: The process of introducing an inert gas or a flue gas into a tank in order to reduce the oxygen content or to reduce the concentration of hydrocarbon vapors by displacement.

3.2.54 qualified person: A person designated by an employer (owner/operator and contractor) as having the necessary training, education and competence to perform assigned tank cleaning and entry related tasks or activities in accordance with the employer's (owner/operator and contractor) policy, procedures, and programs.

3.2.55 rescuers: The personnel designated to rescue entrants from the permit required confined space.

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

3.2.57 retrieval system: The equipment (including retrieval lines, chest or full body harness, wristlets and lifting devices or anchors) used for non-entry rescue of persons from permit required confined spaces.

3.2.58 safe (cold) work: Any work that does not have the potential to create a source of ignition.

3.2.59 shall: Is used to designate requirements presented in this standard that are mandatory.

3.2.60 should: Is used to designate procedures or practices in this standard that are recommended.

3.2.61 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*).

3.2.62 sour: Petroleum products where hydrogen sulfide (H_2S) is present (for example, sour crude oil and sour crude oil fractions contain appreciable amounts of hydrogen sulfide and/or mercaptans and heavy residual fuel oil may contain entrained or entrapped H_2S).

3.2.63 standby person: A qualified person assigned to control and oversee supplied air operations.

3.2.64 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 a

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.

3.2.65 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 (owner/operator and contractor) policies, including, but not limited to, exposure limits developed by the responsible committees of the American Conference of Governmental Industrial Hygienists.

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

3.2.67 vapor and gas 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.

3.2.68 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 (degassing).

3.2.69 work (operations): Any work performed on tanks in accordance with this standard.

3.2.70 worker: A qualified person working in or around a tank during tank cleaning. A worker, working inside a tank, may or may not be an entrant depending on the classification of the tank.

4 Administrative Controls and Procedures

4.1 GENERAL REQUIREMENTS

Employers (owners, operators, or contractors) shall develop and implement appropriate administrative controls, procedures and written plans for tank preparation, entry, and cleaning work from decommissioning through recommissioning, including, but not limited to, the following (see ANSI/API Recommended Practice 2016 for additional information):

a. Scope of work to be performed.

b. Owner/operator responsibilities for each planned operation.

c. Contractor and sub-contractor selection.

d. Contractor and sub-contractor responsibilities for each planned operation.

e. Regulatory requirements and employer (owner/operator and contractor) responsibilities applicable to the specific tank cleaning operations.

f. Requirements and responsibility for permits, records, reports, notifications and record keeping.

g. Hazard assessment and establishment of safe practices, exposure levels and controls for the storage tank(s) and tank area and the operations to be conducted.

h. Hazard assessment and establishment of safe practices, exposure levels and controls for vapor and gas freeing and degassing including testing, monitoring and ventilation requirements, procedures, methods and equipment.

i. Hazard assessment and establishment of safe practices, exposure levels and controls, procedures, responsibilities, materials and equipment for decommissioning, isolation, tank cleaning and handling and disposal of product, sludge and residue.

j. Facility general and tank specific requirements and responsibility for identification, classification and reclassification of the tank (or tank roof) as a permit required confined space, non-permit required confined space and non-confined space.

k. Entry requirements and entry permit, safe (cold) work permit and hot work permit requirements, issuance, limitations, cancellation and responsibilities.

l. Qualified persons, responsibilities, training and personal protective equipment requirements.

m. Emergency response requirements, notification, designated qualified rescuers and rescue operations responsibilities.

n. Procedures and responsibilities for inspecting, testing, recording and returning tanks to service.

o. Requirements for conducting post-tank cleaning reviews and adjusting programs and procedures, as needed.

4.2 WRITTEN TANK CLEANING PROGRAM

Before decommissioning and tank cleaning operations begin and before workers enter tanks for any reason, employers (owners, operators, or contractors) shall develop and implement written tank cleaning programs (including confined space classification and entry) that include, but are not limited to, the following requirements:

4.2.1 Scope of Work

The tank(s) to be cleaned, their identification and classification, their construction and condition, the products contained, the specific work to be done and when each phase of the work is expected to start and to be completed.

4.2.2 Contractor Evaluation

An owners/operator evaluation of contractors and subcontractors experience and training, safety record, equipment, programs and procedures, and ability to accomplish the planned work safely and efficiently in accordance with the contract requirements and applicable standards and regulations. These evaluations are normally performed in order to determine which contractors are qualified to bid (offer tenders) on tank cleaning jobs.

4.2.3 Tank Pre-Cleaning Meetings

Scheduling and conducting tank pre-cleaning job discussions between appropriate employer (owner/operators and contractor) personnel, including, but not limited to, entry supervisors, qualified persons, facility operators, and representatives of involved parties, before work commences. These discussions shall cover, but are not limited to, the following items:

4.2.3.1 Scope of work and specific responsibilities of owner/operator personnel and contractor workers for all aspects of the tank cleaning operation from recommissioning to decommissioning.

4.2.3.2 Requirements of and compliance with the employer's (owner/operator and contractor) confined space, permit and isolation (lockout/tagout) programs.

4.2.3.3 Coordination and communications between owner/operator personnel and contractor personnel working in or around the tank to be cleaned.

4.2.3.4 Responsibility for obtaining required jurisdictional permits and authorizations.

4.2.4 Hazard Evaluation

Identifying and evaluating the elements, hazards and conditions of the tank to be entered and the owner/operator's and contractor's experience this and similar tanks, including an agreement between owners/operators and contractors regarding requirements for acceptable entry and safe tank cleaning operations.

4.2.5 Entry and Work Permit Requirements

Determining acceptable entry and safe work conditions and requirements for the issuance, use and suspension or cancellation of entry, safe (cold) work and hot work permits. Providing information regarding potential hazards and requirements for entry and work in permit required confined space, non-permit required confined space and non-confined spaces to contractors, supervisors and workers.

4.2.6 Confined Space Program

Reviewing and updating the written confined space program to assure compliance with regulatory and facility requirements.

4.2.7 Classification of the Tank

Evaluating, classifying, and identifying a tank as a permit required confined space, non-permit required confined space or a non-confined space. Determining conditions and requirements necessary for the tank's classification to be changed from a permit required confined space to a non-permit required confined space or to classify the tank as a non-confined space.

4.2.8 Removal of Available Product

Determining requirements and assigning responsibility for emptying the tank of available product before decommissioning and isolation work begins.

4.2.9 Qualified Persons

Qualifying, selecting and assigning qualified person(s) at to supervise and perform preparation, decommissioning, testing, supervisory, permit issuance, entry, attendant, standby, cleaning, hot and safe (cold) work, rescue, and recommissioning activities.

4.2.10 Safeguarding the Work Area

Developing and implementing procedures to be followed by employees to control the work area from external hazards, prevent unauthorized entry into tanks and tank cleaning areas and protect workers and equipment in or around tanks using approved measures and safeguards including, but not limited to, locks and tags, barriers, warning signs and tank opening protective devices.

4.2.11 Exposure Control

Developing and implementing procedures and controls to conduct atmospheric testing, analyze results and eliminate or minimize exposures and hazards, including the following:

4.2.11.1 Testing by qualified persons of the atmosphere of the surrounding area and the tank before entry and, as necessary, continuously or periodically testing during entry, safe (cold) work and hot work to determine concentrations of oxygen, flammable vapors and toxic substances.

4.2.11.2 Assuring and verifying that the atmospheric conditions in the tank remain acceptable for entry, safe (cold) work and hot work throughout the duration of the tank cleaning operation.

4.2.11.3 Determining the requirements and providing for personal protective equipment (including respiratory protection), based on the potential exposures.

4.2.12 Tank Cleaning Operations

Developing and implementing appropriate tank cleaning procedures including, but not limited to, decommissioning, tank isolation, product removal, vapor and gas freeing, degassing, purging, inerting, flushing, ventilation, entry, cleaning, sludge handling and disposal, rescue and recommissioning operations. Requirements and responsibility for selecting and supplying tank cleaning equipment.

4.2.13 Inspections

Inspecting the tank for physical and other hazards prior to entry for cleaning or work activities and for materials and foreign objects prior to recommissioning.

4.2.14 Emergency Planning

Preparing and instituting an emergency plan covering emergency responder selection, designation of rescuers, notification procedures, equipment requirements, tank specific rescue procedures and incident reporting requirements.

4.2.15 Compliance

Assuring and verifying worker compliance with applicable facility and contractor policies, procedures and programs and applicable government regulations and standards.

Note: In the United States, confined space regulations include, but are not limited to, requirements promulgated by the U.S. DOL, OSHA, DOT, and EPA, state regulations and applicable fire codes. For example, some of OSHA's requirements for a tank classified as a permit required confined space, include, but are not limited to, posting signs at the tank and allowing employees or their authorized representatives to review the written confined space program and observe atmospheric testing prior to entry. (See OSHA 29 CFR 1910.146 for additional information.)

4.2.16 Recommissioning

Determining responsibility and requirements for recommissioning the tank after tank cleaning is finished, including, but not limited to, inspecting, refilling, testing, and returning the tank back to service.

4.2.17 Post Tank Cleaning Reviews

Conducting post-job discussions between employers (owners/operators and contractors), entry supervisors, qualified persons, and representatives of involved parties after tank cleaning operations are completed that cover the hazards encountered or created during the tank cleaning operation.

4.2.17.1 Conducting post-job reviews by employers (owners/operators and contractors) covering proposed changes to their confined space entry, permit and tank cleaning programs based on the results of reviews of retained records, work experiences, and management of change actions.

4.2.17.2 Conducting an annual review of all tank cleaning operations performed during the past 12 months to assure that employees who participated in entry operations were protected from related hazards, and if exposure in excess of permissible limits occurred, employees have been advised and any required medical surveillance has been initiated.

4.2.18 Records and Permits

Retaining records, including, but not limited to, instrument calibration and adjustment records, atmospheric test results, copies of permits and work orders issued to enter and work in confined space, medical surveillance records for workers exposed to regulated toxic materials, incident reports, waste disposal records, etc. for a period of time in accordance with applicable government regulations and employer (owner/operator and contractor) policy, but at least for 1 year after issuance (unless there is reason or requirement for longer retention).

4.3 QUALIFIED PERSONS

Qualified persons include, but are not limited to, testers, entry supervisors, hot and safe (cold) work permit issuers, attendants, entrants, standby persons, workers, and rescuers.

4.3.1 Selection and Assignment

Employers (owner/operators and contractors) shall ensure that qualified persons are designated and assigned to perform and supervise tank cleaning related tasks or activities in accordance with this standard, applicable regulatory requirements and the employer's (owner/operator and contractor) permit required confined space, tank cleaning and permit programs and administrative control procedures.

4.3.2 Qualifications

Employers (owner/operators and contractors) shall assure that qualified persons are trained, educated, knowledgeable and experienced; familiar with and aware of the potential hazards; take proper precautions and control measures; and use required personal protective equipment.

4.3.3 Responsibilities

Qualified persons shall know their responsibilities and work requirements, be able to perform assigned duties safely

and follow permit requirements and established entry, hot work and safe (cold) work procedures throughout the tank cleaning operation.

4.4 TRAINING REQUIREMENTS

Employers (owners/operators and contractors) shall ensure that employees are experienced, trained or educated to understand the scope of work and potential hazards of the job and have the knowledge and skills necessary for the safe performance of their assigned duties.

4.4.1 Government Requirements

Employer (owner/operator and contractors) shall review appropriate government regulations (in the U.S., this would include DOL, OSHA, DOT, and EPA) to determine the specific training requirements that are applicable to tank cleaning operations.

4.4.2 Industry Requirements

Employers (owner/operator and contractor) shall review employer programs and procedures and applicable industry standards to determine the specific training requirements applicable to tank cleaning operations.

4.5 CONTRACTORS

Contractors conducting tank cleaning and entry work shall understand the hazards, provide proper equipment, use qualified personnel and know and follow the requirements, precautions and procedures described in this standard, mandated by regulatory agencies and established by the facility in order to perform tank cleaning operations safely. (See API 2220 for information regarding contractor safety performance.)

4.5.1 Contractor Evaluation

For all work activities to be undertaken by the contractor, the owner and/or operator shall evaluate the contractor's previous and present experience, performance, work procedures, and practices.

4.5.2 Contractor Responsibilities

Prior to starting work, the owner and/or operator and the contractor shall agree on the tank cleaning requirements, precautions and procedures to be followed by the contractor and the contractor's responsibility for meeting the requirements of the written confined space permit program and entry, hot work and safe (cold) work procedures. The contractor shall advise the owner and/or operator of any potential and actual hazards associated with the chemicals and cleaning agents to be used (such as providing MSDSs) in the tank cleaning activities.

4.5.3 Owner/Operator Responsibilities

The owner or operator of the facility shall advise the contractor of the known potential hazards associated with the subject tank and its contents (such as providing MSDSs) and the surrounding area and any operations being conducted or planned in the area that have the potential to impact upon the contractor's tank cleaning activities.

4.6 TANK CLEANING EQUIPMENT

Employers (owner/operator and contractor) shall provide and maintain equipment, materials and job specific personal and respiratory protection equipment required to conduct tank cleaning operations, including, but not limited to the following items:

4.6.1 Instruments

Testing, sampling and monitoring instruments and appropriate calibration equipment.

4.6.2 Isolating, Ventilating, and Degassing Equipment

Vapor and gas freeing, degassing and ventilating equipment, including but not limited to eductors, air blowers, flexible tubing for suction and exhaust, air compressors, hoses and connectors, tank opening covering and, where required, degassing vapor recovery or vapor treatment equipment. Contractors shall assure that all hoses, valves, flanges, fittings, blinds and gaskets to be used are appropriate for the anticipated exposures and pressures.

4.6.3 Personal Protection

Personal protective equipment, including hearing protection, respiratory protection and clothing specifically required for tank entry and tank cleaning operations at no cost to employees (see OSHA 29 CFR 1910, Subpart I for additional information). Contractors shall assure that personal protective equipment is managed, cleaned and disposed of in accordance with regulatory and employer requirements.

4.6.4 Respiratory Protection

Respiratory protection and associated air supply equipment, including but not limited to, approved breathing air compressors, air cylinders, air hoses, air purifying and supplied air respirators and SCBA. Medically evaluate, fit test and train personnel to use and care for respiratory protective equipment (see OSHA 29 CFR 1910.134 for additional information). Contractors shall assure that respiratory protection equipment is managed, cleaned, maintained and inspected in accordance with regulatory and employer requirements.

4.6.5 Tank Cleaning Equipment and Materials

Tank cleaning equipment, including, but not limited to, vacuum equipment, pumps, approved explosion-proof electrical equipment (where permitted), transfer hose and connections, approved low voltage lighting and flashlights, hoses, ladders, disposal containers, shovels, scrapers, wipers, brushes, squeegees, rags, and sponges.

4.6.5.1 Tank cleaning materials including, but not limited to, water, steam, fuel oil, soap, solvents and approved chemicals.

Note: MSDSs covering hazardous materials shall be available for review by contractor and owner/operator employees.

4.6.5.2 Equipment and materials required to safeguard the workers and the work area, including, but not limited to, barriers, locks and tags; isolation equipment including approved blinds and blanks, gaskets, flanges and bolts; grounding and bonding cables and connections; tank opening covers, screens and protective devices; and fire extinguishers and/or fire hoses.

4.6.5.3 Contaminated equipment and materials and hazardous and flammable tank cleaning materials shall be stored, handled, disposed of in accordance with employer and regulatory requirements.

4.6.6 Emergency Response and Communications Equipment

Any other non-personal equipment required for safe entry, hot work, safe (cold) work and rescue from a specific tank or confined space including, but not limited to, approved communication equipment and warning devices and rescue and emergency response equipment (except when provided by outside services).

5 Preparing the Tank for Entry and Cleaning

5.1 INITIAL PREPARATION

5.1.1 Tank Pre-Cleaning Preparation

Employers (owners/operators and contractors) shall assure that during planning and conducting tank cleaning operations, the essential elements for preparing a tank for safe entry and cleaning are considered, including, but not limited to, the following:

5.1.1.1 Employers (owners/operators and contractors) shall review available drawings and sketches of the external and internal tank configuration, piping and valves, supports, floating roof design, appurtenances and the site layout and develop plans to mitigate or control the potential physical hazards to be expected before and during the tank cleaning operation.

5.1.1.2 Employers (owner/operators and contractors) shall obtain and review applicable MSDSs or equivalent information concerning the products presently and previously 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. (In the United States, OSHA 29 CFR 1910.1200 requires that MSDSs and other information regarding potential hazardous exposures from products and materials be available at the work place for employee review.)

5.1.1.3 Employers (owners/operators) shall establish requirements for the evaluation and classification of tanks to be cleaned and 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 process.

5.1.1.4 Employers (owners/operators or contractors) 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.

5.1.1.5 Employer (owner/operator) and contractor supervisors and qualified persons shall conduct a tank pre-cleaning meeting to review the above information, establish basic permit requirements and assign specific responsibility for each phase of the tank cleaning operation.

5.1.2 Procedures and Plans

Employers (owners/operators and contractors) shall develop written procedures and work plans that provide for safe tank cleaning operations from decommissioning to recommissioning.

5.1.2.1 Employers (owners/operators and contractors) shall assure that the procedures and work plans provide applicable information and guidance so that entry supervisors and qualified persons may anticipate, recognize, test, analyze and determine appropriate measures to control potential hazards that may be encountered during tank cleaning operations.

5.1.2.2 Employers (owners/operators and contractors) shall prepare written procedures and a detailed work plan covering decommissioning, product removal, tank isolation, vapor and gas freeing, degassing, ventilation, testing, inspection, entry, cleaning, construction, repair or maintenance work, rescue, refilling and recommissioning in accordance with the facility and contractor tank cleaning, permit and confined space programs.

Note: In the United States, when entry into an OSHA permit required confined spaces is contemplated, OSHA 29 CFR 1910.146 requires that this plan be made available for review by employees and their authorized representatives (see ANSI/API Recommended Practice 2016 for a detailed checklist of items).

5.1.2.3 Owners/operators shall establish (with contractor's agreement), the appropriate permit requirements covering decommissioning, emptying, isolating, vapor and gas freeing, degassing, ventilation, testing, inspecting, entering, inspecting, cleaning, sludge and residue handling, refilling, recommissioning and hot and safe (cold) work performed in and around the tank.

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

5.2 TYPICAL TANKS

Employers (owners/operators and contractors) shall be familiar with the different types of above ground petroleum storage tanks to be cleaned and their components and characteristics. The most common types of tanks are fixed (cone) roof, external (open top and covered) floating roof and internal floating roof tanks.

5.2.1 Fixed (Cone) Roof Tanks

5.2.1.1 Fixed (cone) roof tanks roofs have vents, roof fittings, accesses and ladders that penetrate the roof and serve various operational functions (see ANAI/API Recommended Practice 2016 for additional information).

5.2.1.2 Some fixed (cone) roof tanks may have vapor conservation appurtenances, such as internal bladders or a smaller, external fixed (cone) roof tank mounted on top of the roof of the tank. These tanks pose unique problems for tank cleaning.

5.2.2 External (open-top) Floating Roof Tanks

The basic components of external (open-top) floating roof tanks include, but are not limited to, the following:

5.2.2.1 A cylindrical shell and pontoon, pan-type or combination steel or aluminum floating roof.

5.2.2.2 Primary and/or secondary annular rim seals attached to the floating roof perimeter.

5.2.2.3 Vents, flame arrestors, foam systems, roof fittings, shunts, anti-rotation devices, movable stairways and ladders that are attached to or penetrate the roof.

5.2.2.4 Roof drains to drain water from the roof (may be deactivated and sealed).

5.2.3 Internal and Covered Floating Roof Tanks

Internal and covered floating roof tanks may include all or some of the following components:

5.2.3.1 A fixed (cone) roof supported by vertical columns within the tank (typical of fixed-roof tanks built or retrofitted with an internal floating deck).

5.2.3.2 An internal floating roof constructed of metal, plastic or metal covered expanded plastic foam materials.

5.2.3.3 Honeycomb panels, pontoons or pans, solid buoyant materials or a combination of these types of roof construction to provide flotation.

5.2.3.4 Seals to prevent vapor release, anti-rotation devices and ladders to provide access from the fixed roof.

5.3 DECOMMISSIONING

During the tank pre-cleaning meeting, employers (owners/operators and contractors) shall determine the responsibilities for decommissioning the tank, including setting legs and removing, handling, storing, and disposing of recoverable and non-recoverable product, sludge and residue.

5.3.1 Setting Floating Roof Legs

When tank cleaning is first scheduled and the tank still contains product, owners/operators (or contractors) shall assure that the legs on the floating roof are properly adjusted (preferably in the high position) to allow room for entrants to work underneath the roof after the tank is emptied. (See ANSI/API Recommended Practice 2016 and API 2026 for additional information on setting roof legs.)

5.3.1.1 Before emptying the tank, a qualified person shall assure by visual or other means of inspection, that all roof legs are pinned at the same height, either high or low (see ANSI/API Recommended Practice 2016 for additional information).

5.3.1.2 Employers (owner/operators or contractors) shall establish the criteria for entry upon a floating roof as permit required confined space entry, non permit required confined space entry or non-confined space entry.

Note: It is petroleum industry practice to normally consider entry upon an open-top floating roof that is within five (5) feet 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.

5.3.2 Recoverable Product

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

5.3.3 Non-Recoverable Product

The non-recoverable 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 (owner/operator and contractor) for the specific tank cleaning operation (see ANSI/API Recommended Practice 2016 for guidance regarding specific procedures for emptying tanks of recoverable and non-recoverable product).

5.4 ISOLATING THE TANK

During the tank pre-cleaning meeting, employers (owners/operators and contractors) shall determine the responsibilities for isolating the tank, including, but not limited to, product lines, sample and gaging lines, alarm systems, heating and mixing devices, foam lines, appurtenances, relief and vapor recovery lines, energy sources, and cathodic protection systems.

5.4.1 Isolating Lines

Employers (owners/operators or contractors) shall assure that the tank is isolated from all lines connected to the tank, including, but not limited to, product, vapor, relief, gauging and sampling, and water draw off lines (see foam lines, below). Lines shall be isolated as close to the tank as possible by installing blanks between two flanges, using two gaskets and fully engaged bolts or stud bolts in all flange bolt-holes. Double block and bleed valves with lockout/tagout devices may also be approved to isolate lines (see OSHA 29 CFR 1910.147 for additional information). Blanks shall have a handle extending beyond the flange with a $^1/_4$-inch minimum hole in the handle (see ASME B 31.3 for additional information). Lines disconnected from the tank shall have blinds installed across the opening, using a gasket and fully engaged bolts or stud bolts in all flange bolt-holes (see ASME B 16.5 and B 16.47 for additional information). 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 they have no cracks, pits, or holes.

5.4.2 Isolating Energy Sources

During pre-planning and pre-cleaning, the employer (owner/operator and contractor) shall review the employer's lockout/tagout program and determine and implement the applicable requirements necessary to safeguard the tank and during isolation (see OSHA 29 CFR 1910.147 for additional information). Entry supervisors shall assure that all energy sources (including, but not limited to, electrical, steam, hydraulic and mechanical) and all tank equipment and appurtenances (including, but not limited to, tank mixers, heaters, sensors, and other instrumentation) are isolated by disconnecting, and blinded, blanked, or double blocked and bled. The employer shall also check alarms and determine whether or not isolation is necessary. Isolation devices shall be locked/tagged out and tested (where required or appropriate) before beginning tank cleaning operations (see ANSI/API Recommended Practice 2016 and OSHA 29 CFR 1910.147 for additional information).

5.4.3 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. The system shall be checked to assure that it is in proper operating condition and the lines shall remain connected throughout the tank cleaning operation in the event of a fire within the tank.

5.4.4 Cathodic Protection

If a tank or lines have cathodic protection, the employer (owner/operator and contractor) shall assure that whenever a tank valve or line is to be disconnected, safe isolation practices are followed, in the order shown (see API 2003 for additional information).

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.

5.5 CONTROL OF IGNITION SOURCES

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 (see ANSI/API Recommended Practice 2016 for additional information).

5.5.1 Motorized (Internal Combustion) Equipment

Before issuing entry or work permits, entry supervisors and qualified persons shall require that internal combustion powered equipment (including, but not limited to, 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 and qualified persons shall be aware that the use of diesel powered internal combustion equipment is preferred to using gasoline or gas powered equipment.

5.5.2 Electrical Tank Equipment

Entry supervisors shall assure that all electrical equipment and appurtenances that a qualified person has determined may create sufficient energy to 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, but are not limited to, metering devices, alarms, sensors, overflow protection systems, cathodic protection systems, and electrical heating coils.

5.5.3 Electrical Tank Cleaning and Maintenance Equipment

Depending on the potential exposures, entry supervisors shall assure that all electrically powered tank cleaning and related equipment, including but not limited to, 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 (see NFPA 30 and NFPA 77 for additional information).

5.5.4 Electrical Bonding and Grounding (Earthing)

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 and qualified persons shall assure that equipment capable of creating an ignitable spark upon disconnection is properly bonded and grounded (earthed) before issuing permits (see API 2003, API 2219 and NFPA 77 for additional information). Supervisors and qualified persons shall assure that bonding and grounding procedures include, but are not limited to, the following requirements:

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

5.5.4.2 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.

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

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

5.5.4.5 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).

5.5.4.6 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.

5.5.4.7 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.

5.5.5 Ignition Sources From Compressed Air

Employers (owners/operators and contractors) shall require and entry supervisors shall assure that air compressors are equipped with appropriate filters to remove moisture, scale, rust, and oil 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.

5.5.6 Lightning and Thunderstorms

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

5.5.6.1 The entry and work permits shall be cancelled.

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

5.5.6.3 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.

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

5.5.6.5 Entrants, attendants, standby persons and tank cleaning workers shall leave the immediate area around the tank and move to a designated safe location.

5.5.7 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 (see ANSI/API Recommended Practice 2016 for additional information).

5.6 VAPOR AND GAS FREEING, DEGASSING, AND VENTILATING

Employers (owners/operators and contractors) 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.

5.6.1 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:

5.6.1.1 Vapor and gas freeing by the use of mechanical or natural ventilation.

5.6.1.2 Displacing vapors and gas by purging the tank with inert gas, flue gas or steam.

Note: Atmospheric testing is required before permitting entry because purging also displaces the air (oxygen) in the tank.

5.6.1.3 Displacing the vapors or gas with water or fuel oil.

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

5.6.2 Vapor and Gas Freeing Selection

Entry supervisors shall be aware of the requirements and shall select specific methods for vapor and gas freeing and degassing the tank dependent upon, but not limited to, the following factors (see ANSI/API Recommended Practice 2016 for additional information):

5.6.2.1 The nature of the vapors or gases involved.

5.6.2.2 Degassing and emission control requirements.

5.6.2.3 The potential hazards of the vapor or gas.

5.6.2.4 The area and the type, size, construction, and location of the tank.

5.6.3 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.

5.6.4 Environmental Factors

During the tank pre-cleaning phase of the operation, and prior to the start of vapor and gas freeing and degassing, employers (owners/operators and contractors) 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 (see ANSI/API Recommended Practice 2016 and EPA 40 CFR 260-271 for additional information).

5.7 INITIAL TANK CLEANING

The employer (owner/operator and contractor) 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 (manhole). 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 (see ANSI/API Recommended Practice 2016; ANSI Z117.1; NFPA 326; and OSHA 29 CFR 1910.146 for additional information).

6 Testing the Tank Atmosphere

6.1 ATMOSPHERIC TESTING PROCEDURES

Prior to the initiation of tank cleaning activities, the employer (owner/operator and contractor) shall establish written procedures and requirements for testing the atmosphere around the outside of the tank and inside the tank during tank preparation, decommissioning, vapor and gas freeing, degassing, inspection, ventilation, tank cleaning and working inside the tank after cleaning. Atmospheric testing procedures and requirements shall be implemented by the entry supervisor and other supervisors and qualified persons, when issuing the work and entry permits.

6.2 ATMOSPHERIC TESTING INSTRUMENTS

6.2.1 General

A qualified person shall test, sample and monitor the atmosphere around and inside the tank using properly calibrated and adjusted, direct reading instruments that are either 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 and ANSI/API Recommended Practice 2016; ANSI Z117.1; NFPA 326; and NIOSH 2533 for additional information).

6.2.1.1 Reference shall be made on the entry permit by a qualified person or the entry supervisor identifying the appropriate MSDSs or equivalent information used to determine substances contained in specific products for which the atmosphere shall be tested in order to evaluate tank entry conditions.

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

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

6.2.1.4 Qualified persons who use testing instruments shall be knowledgeable of and follow manufacturers' recommendations and procedures, including, but not limited to, instrument use and limitations, calibration, adjustment, bump-testing, maintenance, and repair.

6.2.1.5 The employer (owner/operator and contractor) shall develop written instrument calibration and adjustment requirements based on the manufacturer's recommendations. The employer (owner/operator and contractor) shall consider the instrument's usage, the type and amount of exposure to contaminants and the history of need for re-calibration when determining the calibration and adjustment criteria for specific instruments under specific working conditions.

6.2.1.6 The employer (owner/operator and contractor) shall maintain verification of instrument calibration and adjustment 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).

6.2.2 Oxygen Monitors

Employers (owners/operators and contractors) shall designate approved direct reading oxygen measuring instruments (oxygen monitors), which are available as separate instruments or as part of a combination instrument (for example, a combination oxygen meter and combustible gas indicator). A qualified person shall test the atmosphere inside the tank for oxygen content using an approved oxygen monitor prior to testing for flammable vapors and entry (see ANSI/API Recommended Practice 2016 and ISGOTT for additional information).

6.2.2.1 A qualified person shall adjust (calibrate) the oxygen meter in fresh air to 21% oxygen.

Note: Meters, including those used to test inert spaces, shall be tested for zero % oxygen (±0.5%) using nitrogen.

6.2.2.2 Entry supervisors shall evaluate the oxygen levels in the tank's atmosphere for entry under permit required and non-permit required confined space requirements, safe (cold) work and hot work (see Section 8 of this standard for further information) permit requirements..

6.2.3 Flammable Vapor (Combustible Gas) Indicators

Employers (owners/operators and contractors) shall designate approved direct reading combustible gas indicators that measure flammable vapor-in-air concentrations as a percentage of the lower explosive (flammable) limit, with 100 percent being the beginning (lower limit) of the explosive (flammable) range. Combustible gas indicators are available as separate instruments or as part of a combination instrument (for example, a combination oxygen meter and combustible gas indicator). After determining that the oxygen level is within required parameters, a qualified person shall test the atmosphere in and around the tank for flammable vapor-in-air concentrations using approved flammable vapor (combustible gas) indicators that are properly calibrated and adjusted. (See ANSI/API Recommended Practice 2016 and ISGOTT for additional information.)

6.2.3.1 A qualified person shall adjust the indicator in fresh air and test the batteries.

6.2.3.2 The flammable vapor (combustible gas) indicator shall be calibrated by a qualified person using a suitable calibration gas of known concentration, that is appropriate for the type of hydrocarbon vapor being tested, as specified or recommended by the instrument manufacturer.

6.2.3.3 Prior to conducting testing for entry or reentry, the indicator shall be "bump tested" by a qualified person by subjecting the instrument to a small amount of calibration test gas (or challenge gas) to verify that the sensors and alarms respond and function correctly.

6.2.3.4 Entry supervisors shall assure that flammable vapor-in-air levels in the atmosphere both inside and outside the tank are tested and evaluated for safe (cold) work, hot work and entry before issuing permits.

6.2.3.5 The qualified person shall assure that flammable vapor (combustible gas) indicators used to measure vapor concentrations inside and emitted from storage tanks that

have been in leaded service are provided with organic lead filters to protect the instrument from contamination (in order to obtain accurate readings). (See ANSI/API Recommended Practice 2016 for additional information.)

6.2.3.6 The qualified person shall assure that combustible gas indicators used to measure vapor concentrations inside and emitted from storage tanks where moisture and/or dust may be present are provided with appropriate water traps and/or dust filters to protect the instrument and obtain accurate readings (see ANSI/API Recommended Practice 2016 for additional information).

6.2.4 Toxic Substance Indicators and Instruments

A qualified person shall test the atmosphere in and around the tank for the presence of toxic and harmful substances using direct reading measuring instruments or approved detector tubes.

6.2.4.1 Employers (owners/operators and contractors) shall designate the appropriate direct-reading instruments required to measure very low concentrations of toxic hydrocarbons (for example, benzene, xylene, and tolulene) and other toxic substances (for example, hydrogen sulfide) that may be present during tank cleaning operations.

6.2.4.2 Employers (owners/operators and contractors) shall designate appropriate detector tube and other measuring systems and approve their use to measure higher concentrations of hazardous, but less acute toxic substances (such as dusts, cleaning chemical vapors and welding fumes).

6.2.4.3 The employer (owner/operator and contractor) shall assure that the qualified persons conducting the tests are able to correctly select, calibrate, adjust, and use appropriate approved instruments, analyze and interpret test results and understand the limitations of detector tubes and instruments used to measure toxic exposures.

6.2.4.4 Qualified persons shall follow manufacturers' recommendations and employer (owner/operator and contractor) procedures to calibrate and adjust indicators and instruments. When necessary, testers shall check and "bump-test" their instrument prior to use by subjecting it to a small amount of calibration test gas (or challenge gas) to verify that the sensors and alarms respond and function correctly.

6.2.4.5 A qualified person shall test the tank's atmosphere and the surrounding area for toxic exposures as often as necessary (as required by the permit) so that tank entry conditions can be determined and safe (cold) work or hot work can be conducted.

6.2.4.6 Employers (owners/operators and contractors) shall assure that entry supervisors are educated and understand the results and limitations of the toxic exposure testing.

6.2.4.7 Qualified persons shall use special approved instruments to measure levels of radioactivity of products that have the potential to contain naturally occurring radioactive materials (NORM).

6.2.4.8 Qualified persons shall use approved lead-in-air analyzers (or test kits) to determine tetraethyl and/or tetramethyl organic lead-in-air concentrations in tanks that contain or have previously contained leaded gasoline, lead additives, or products containing lead (and have not previously been cleaned and documented as lead hazard free). Qualified persons may also use portable gas chromatographs to measure organic lead-in-air concentrations (see ANSI/API Recommended Practice 2016 and API 2202; ISGOTT; and OSHA 29 CFR 1910.125 for further information). Entry supervisors and testers shall be aware that detector tubes and other non-approved instruments will not accurately detect organic lead vapors and are not to be used for organic lead testing.

6.3 ATMOSPHERE TESTING

6.3.1 General

A qualified person, trained in appropriate testing procedures and the proper selection, inspection, calibration and adjustment, use, maintenance and care of testing instruments, shall measure the atmospheric concentrations of oxygen, flammable vapors and toxic materials outside and inside the tank. The qualified person performing the testing shall verify that the instruments are in working condition, within calibration and properly adjusted prior to testing.

6.3.2 Entry Requirements

Entry supervisors shall require that oxygen, flammable vapors and toxic hazard exposures be tested by a qualified person prior to permitting entry into any 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. These tanks may be devoid of oxygen due to rusting or contain a flammable atmosphere due to product that may have seeped into the tank from a variety of sources.

6.3.2.1 After initial tests indicate that entrants may enter the tank and before entry is permitted, entry supervisors shall determine whether periodic or continuous atmospheric monitoring shall be required to ensure the safety of entrants.

6.3.2.2 Where entry is permitted into a tank identified be the employer (owner/operator or contractor) as an OSHA (U.S. Department of Labor) permit required confined space, entry supervisors shall assure that entrants and attendants (or their authorized representatives) have an opportunity to observe the initial pre-entry testing and any subsequent testing.

6.3.3 Testing Requirements

A qualified person or entry supervisor shall determine the atmospheric tests that must be conducted and when to conduct initial testing and subsequent testing and monitoring of the levels of oxygen, hydrocarbon vapor and toxic concentrations required to perform specific work activities safely. Such determinations shall be based on a number of factors including, but not limited to, the following:

6.3.3.1 The crude oil, products or additives that have been contained in the tank since it was last cleaned and the materials used to vapor free and clean the tank.

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

6.3.3.3 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 Sequence

Most combustible gas indicators work on a design principle that depends on the presence of adequate oxygen levels to obtain accurate readings. For this reason, 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. (This order of testing is specifically mandated in OSHA 29 CFR 1910.146 and other applicable standards.)

6.3.5 Testing the Atmosphere Outside the Tank

Entry supervisors shall require that a qualified person test and monitor the atmosphere around the exterior of the tank, continuously or periodically as required, during vapor and gas freeing, degassing and ventilation operations to ensure that flammable and toxic vapors are not present above acceptable or permissible levels.

Note: Entry supervisors shall determine and implement specific procedures required when testing a tank that has been inerted or purged.

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

6.3.5.2 Tests shall be taken by a qualified person at the point where vapors are being exhausted from the tank and in the areas around the tank where vapors could collect.

6.3.5.3 Based on the results of the testing, the entry supervisor shall determine the potential hazards and permit requirements so that tank cleaning work and other activities can be conducted safely in the vicinity of the tank.

6.3.6 Testing the Atmosphere Inside the Tank

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.

Note: Whenever possible, it is desirable to test the tank's atmosphere from the outside without entering the tank. Qualified persons entering the tank to conduct testing shall follow the entry requirements specified in this standard.

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

6.3.6.1 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. (See ANSI Z117.1, API Recommended Practice 2016 and API 2217A, ISGOTT, NFPA 326, OSHA 29 CFR 1910.132-136 and 1910.146 for additional information.)

6.3.6.2 Entry supervisors shall require that vapor and gas freeing, degassing and ventilating equipment is shut down for at least 15 minutes prior to atmospheric testing (based on industry experience for 150 foot 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.

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

6.3.6.4 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 foot (1.2 meter) verticals intervals (from top to bottom) to assure that flammable and toxic vapors have not stratified within the tank.

6.3.6.5 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 decision can be made by the entry supervisor that personnel may safely enter the tank to conduct inspections or to work. In order to establish that permissible entry conditions exist throughout the tank, the entry supervisor or qualified person shall determine if there is a need to test the atmosphere at various elevations or levels inside the tank. This is required where stratification may have occurred due to tank configuration, difficulty of vapor and gas freeing, incomplete ventilation or presence of inert gases used to purge the tank.

6.3.7 Lead-in-Air Testing

Tanks shall be considered as having been in leaded service unless the complete lifetime tank history is known and documentation exists that:

a. Tanks have never been in leaded service, or

b. Tanks that have previously been in leaded service have been cleaned, tested and declared to be lead hazard free.

6.3.7.1 Entry supervisors shall assure that testing for organic lead-in-air in tanks that have contained, or may have previously contained leaded gasoline, lead additives or products containing lead additives, is performed only after the tanks have been vapor and gas freed (degassed), ventilated and thoroughly cleaned and dried. 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.

6.3.7.2 Entry supervisors shall require that all testers, attendants, entrants and rescuers use appropriate approved personal protective clothing and equipment and air supplied or self contained breathing air (SCBA), positive-pressure, full facepiece, respiratory protective equipment, until a tank is vapor free, cleaned, dried, and tested and determined to be lead-hazard-free (see ANSI/API Recommended Practice 2016 for additional information).

6.3.8 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 entrants are inside the tank, to ensure that desired atmospheric conditions are maintained in accordance with the entry permit, safe (cold) work and hot work requirements. Where entry is made into an OSHA permit required confined space, entrants (or their authorized representatives) shall have the opportunity to observe the testing and monitoring (see ANSI Z117.1, API 2217A, ISGOTT, NFPA 326, OSHA 29 CFR 1910.132-136 and 1910.146 for additional information).

6.3.9 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 entrants (or their authorized representatives). The employer (owner/operator and contractor) shall maintain verification of instrument calibration and adjustment on record for at least 1 year (or the period of time required by applicable regulations or designated in the facility confined space program, if longer).

7 Storage Tank Hazards

7.1 GENERAL

7.1.1 Hazards

All aboveground, atmospheric, low pressure storage tanks that have contained crude petroleum, petroleum products, additives, sludge, or residue have the potential to present one or more of the following hazards during some phase of tank decommissioning, isolation, preparation, entry, testing, inspection, cleaning, repair, and recommissioning operations (see ANSI/API Recommended Practice 2016 for additional information):

- Oxygen deficiency or enrichment.
- Fires and explosions.
- Toxic substance exposures.
- 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 provided that 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 a tank that has contained petroleum, petroleum products or hazardous materials; 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, provided that entry 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 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

A tank may be oxygen deficient for a number of reasons, including, but not limited to, the following:

7.2.2.1 Oxygen may be deficient if the tank has not been properly vapor and gas freed (degassed) and ventilated and flammable or toxic vapors, steam, water mist or inert gases are still present (see ISGOTT for additional information on oxygen deficiency).

7.2.2.2 Product or vapors may have entered the tank from a variety of sources, including vapors from sludge, deposits and residue on tank walls, floors and roofs and liquids under floors and in supports, lines and pontoons. The vapors of most hydrocarbons stored in atmospheric and low pressure tanks are heavier than air and will displace or dilute air (oxygen).

7.2.2.3 If a tank has been closed for an extended period of time, even if previously cleaned, oxidation (rusting) may have depleted the tank's oxygen content.

7.2.2.4 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 (see API 2217A for information concerning work in inert confined spaces).

7.2.2.5 When welding, cutting or other hot work is performed in an enclosed space, the air in the tank may be displaced or the oxygen in the air depleted through combustion.

7.2.2.6 A tank whose interior has been painted, lined or coated may have an oxygen deficiency due to evaporation of solvents.

7.2.3 Oxygen Enrichment

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 action shall be taken:

7.2.3.1 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.

7.2.3.2 Entry supervisors or qualified persons 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).

7.2.3.3 Entry supervisors or qualified persons shall determine and implement the corrective action required to eliminate or control the oxygen enrichment.

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

7.3 FIRE AND EXPLOSION HAZARDS

7.3.1 General

Fires and explosions will 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 cleaning, from decommissioning through recommissioning, but the potential is particularly prevalent during vapor and gas freeing and degassing.

7.3.1.1 During tank cleaning operations, entry supervisors shall control vapor exhaust and ignition sources in the vicinity of the tank to prevent possible ignition of flammable vapors.

7.3.1.2 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 (see NFPA Fire Protection Handbook, NFPA 30 and API 650 for additional information):

1. Tank design, construction, condition and integrity.
2. Product(s) that have been stored in the tank.

3. Flammable vapor-in-air concentration that may be present due to inadequate cleaning or ventilation, product seepage or leakage into the tank, from chemicals used to clean the tank or from the application of paint, linings or coatings.

4. The number of open vents, relief devices and other tank openings.

7.4 TOXIC SUBSTANCES

7.4.1 General

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, attendants, entrants, testers, workers and qualified persons shall be 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.

7.4.1.1 Information about the materials contained in the tank, including applicable MSDSs, 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 supervisors and workers at the tank cleaning work site (see ANSI Z117.1, NFPA 326 and ACGIH for additional information).

7.4.1.2 A qualified person shall review regulatory requirements applicable to the potential toxic exposures and update protection and entry requirements (see OSHA 29 CFR 1910.1000 and 1910.1200 for additional information).

7.4.1.3 Entry supervisors shall determine and assure that the safe exposure levels for entry and the protective clothing, equipment and respiratory protection required for entrants are within acceptable limits, before an entry permit is issued (see ANSI Z88.1, API 2026 and API 2217A and OSHA 29 CFR 1910.132-136 and 1910.134 for additional information).

7.4.2 Hydrogen Sulfide

Hydrogen sulfide is an extremely toxic and flammable gas that occurs in the production, storage and refining of sour crude oil and crude oil fractions.

Note: Sweet crude oil and its components do not normally present a hydrogen sulfide exposure hazard unless there is or has been oil-reducing or sulfate-reducing bacteria in the tank or a mixture or other error has occurred. (See ACGIH, ISGOTT, NIOSH, and OSHA 29 CFR 1910.1000 for further information.)

7.4.2.1 Employers (owners/operators and contractors) shall establish and require mandatory precautions, procedures and controls for prevention of exposure to hydrogen sulfide gas.

7.4.2.2 Entry supervisors shall assure that workers follow the applicable regulatory and facility precautions, procedures and controls required for potential exposure to hydrogen sulfide, including the use of air supplied or self contained breathing apparatus, when required.

7.4.2.3 Entry supervisors shall assure that all work activities related to tank cleaning and entry, performed on or around tanks containing sour crude oil and crude oil fractions, are conducted with extreme caution, under permit conditions.

7.4.3 Organic Lead

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 (see API Recommended Practice 2016, API 2022, and API 2207; ACGIH; ISGOTT; and OSHA 29 CFR 1910.1025 for further information).

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

7.4.3.2 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.

7.4.3.3 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.

7.4.3.4 Employers (owners/operators or contractors) shall establish and implement procedures for decontamination and disposal of contaminated clothing and materials and provide workers with appropriate facilities for washing and changing.

7.4.3.5 Employers (owners/operators or contractors) shall establish and implement procedures for testing and disposal of product, sludge, deposits and residue that contain organic lead.

7.4.4 Inorganic Lead

Inorganic lead may be present in paints and coatings used on tanks and piping and may also be present in sludge, resi-

due and products such as gear lubricants and metal working fluids containing inorganic lead additives. Exposure to inorganic lead can occur during cleaning operations including, but not limited to, sludge, deposit and residue removal, grinding, blast cleaning and scraping (see ACGIH, API 2202, ISGOTT, and OSHA 29 CFR 1926.62 for further information).

7.4.4.1 Entry supervisors shall assure that workers are aware of employer (owner/operator and contractor) 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 during tank cleaning operations.

7.4.4.2 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.

7.4.4.3 Employers (owners/operators or contractors) shall establish and implement procedures for decontamination and disposal of contaminated clothing and materials and provide workers with appropriate facilities for washing and changing.

7.4.4.4 Employers (owners/operators or contractors) shall establish and implement procedures for testing and disposal of blasting grit, paint deposits and residue that contain inorganic lead.

7.4.5 Aromatics

Some aromatic compounds found in petroleum hydrocarbons such as benzene, have been determined to have the potential to cause cancer (see ACGIH, ISGOTT, and OSHA 29 CFR 1910.1028 for additional information).

7.4.5.1 Depending on applicable regulatory requirements and facility procedures, the employer (owner/operator and contractor) shall establish and the entry supervisor shall implement requirements for safe entry and work where there is a potential for exposure to aromatic hydrocarbons during tank cleaning operations, material handling and waste disposal.

7.4.5.2 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.

7.4.5.3 Employers (owners/operators or contractors) 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 and washing.

7.4.6 Naturally Occurring Radioactive Materials (NORM)

Crude oil (and sludge or residue from crude oil tanks) may contain naturally occurring radioactive materials (NORM) (see API E2 for additional information).

7.4.6.1 Depending on applicable regulatory requirements and facility procedures, the employer (owner/operator and contractor) shall establish and the entry supervisor shall implement requirements for safe entry and work where there is a potential for exposure to naturally occurring radioactive materials (NORM) during tank cleaning operations, material handling and waste disposal.

7.4.6.2 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).

7.4.6.3 Employers (owners/operators or contractors) 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 and washing.

7.4.7 Other Toxic Materials

Entry supervisors shall assure that a qualified person reviews applicable MSDSs 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.

7.4.7.1 A qualified person shall also review MSDSs 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.

7.4.7.2 The employer (owner/operator and contractor) 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.

7.4.7.3 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 toxic exposure.

7.4.7.4 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.

7.4.7.5 Employers (owners/operators or contractors) 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 and washing.

7.5 PHYSICAL AND OTHER HAZARDS

Physical and other hazards may be present or created both inside and outside the tank during tank cleaning and entry operations. Supervisors, attendants, entrants, workers and rescuers shall be aware of potential physical hazards and the symptoms of physiological and psychological hazards.

7.5.1 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.

7.5.2 Hazard Identification

Entry supervisors, testers, entrants, attendants, rescuers and 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:

7.5.2.1 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 floor.

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

7.5.2.3 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.

7.5.2.4 Physiological hazards, including, but not limited to, heat stress and cold stress inside tanks and exposure to extreme cold or inclement weather outside of tanks.

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

8 Hazard Assessment for Entry Permits

8.1 GENERAL

Entry supervisors shall issue entry permits for all entries into tanks that have been classified as either permit required or non-permit required confined spaces, regardless of the planned activity or work to be performed.

8.1.1 Entry Conditions

The employer (owner/operator or contractor) shall perform a hazard analysis and establish the conditions and precautionary requirements for entry into tanks that are classified as permit required confined spaces, non-permit required confined spaces and non-confined spaces.

8.1.1.1 Entry supervisors and qualified persons shall identify potentially prohibitive entry conditions, and establish requirements for canceling the entry permit, stopping work and vacating the tank, should such conditions arise. These requirements shall depend upon the potential hazards associated with the entry, including, but not limited to, the following:

1. Other operations affecting the work in the tank and in the area outside the tank.
2. Internal and external atmospheric test results that are not within established limits.
3. Weather conditions and emergencies occurring in the vicinity of the tank.
4. Tank structural conditions, physical hazards and constraints.
5. Tank cleaning operations or work to be performed inconsistent with permit authorization or requirements.
6. Work shift change, permit expiration, evacuation, unforeseen hazard and other consequences.

8.1.1.2 Entry into tanks classified as non-confined spaces shall require that an entry supervisor or qualified person evaluate the situation and issue either a safe (cold) work or hot work permit depending on the activity or work to be performed. Should testing of the tank be required prior to entry by workers, the entry supervisor shall issue an entry permit for the tester to enter the tank.

8.1.2 Operating Conditions

Entry supervisors, testers, attendants and entrants shall be aware that one of the most important entry permit requirements is the ability to maintain safe operating and atmospheric conditions throughout the entry period.

8.1.2.1 Attendants shall carefully monitor existing conditions throughout the entry, as necessary, to ensure conditions

remain within permitted entry level requirements. If conditions change during the course of entry, the permit shall be cancelled, all work shall stop and entrants shall exit the tank.

8.1.2.2 Before work is allowed to resume, entry supervisors shall assess the conditions and, if acceptable, reissue the entry permit or issue a new entry permit.

8.1.3 Record Retention

Employers (owners/operators and contractors) shall maintain copies of the entry permits and atmospheric testing documentation on file for at least one year, or longer (if required by employer policy or government regulation), to verify that atmospheric and physical conditions were properly evaluated and to assist in the post tank cleaning review and analysis of entry procedures.

8.2 LEVELS OF ENTRY

8.2.1 General

Entry supervisors shall review and analyze the atmospheric and physical conditions within and around the tank in order to determine the requirements, protective measures and precautions necessary for safe entry into tanks. Entry supervisors shall also consider the activities or work to be performed and the classification of a tank as a permit required confined space, a non-permit required confined space or a non-confined space, when determining the level of entry.

8.2.1.1 Permit Required Confined Space

A tank shall be classified as a permit required confined space provided it meets all of the confined space requirements and also has one or more of the following four characteristics:

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

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

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

4. Contains any other recognized serious safety or health hazard.

8.2.1.2 Non-Permit Required Confined Space

A tank shall be classified as a non-permit required confined space provided it does not have any of the permit required confined space characteristics but does meet all of the following three confined space requirements:

1. Is large enough and so configured that entrants can enter and work.

2. Has limited or restricted means for entry or exit.

3. Is not designed for or meant to be continuously occupied by employees.

8.2.1.3 Non-Confined Space

Tanks that do not meet any of the four permit required confined space criteria and do not meet any of the three confined space requirements may be identified and classified by the employer (owner/operator or contractor) as non-confined spaces.

8.2.2 Entry Levels

Entry supervisors shall recognize that the level of entry posing the least risk is preferable, and follow this standard, applicable government regulations and industry practices in determining which one of the following three entry level classifications is appropriate for the planned work or activity:

8.2.2.1 Entry into tanks that are classified as permit required confined spaces is the most restrictive of the three levels. This level provides entry into tanks requiring special precautions, including, but not limited to, entry into tanks maintained under inert gas or tanks where atmospheric conditions are immediately dangerous to life and health (IDLH).

8.2.2.2 The second level is entry into tanks classified as non-permit required confined spaces.

8.2.2.3 Entry into tanks that are classified as non-confined spaces is the least restrictive level and provides requirements for entry into tanks that are no longer classified as (or considered to be) confined spaces.

8.2.2.4 The purpose of having three levels of entry in this recommended procedure is to ensure consistency with regulatory requirements (OSHA 29 CFR 1910.146) and industry requirements (ANSI Z117.1 and NFPA 326) while providing the ability for the employer (owner/operator or contractor) to safely and reasonably conduct tank cleaning operations.

8.3 ENTRY INTO TANKS CLASSIFIED AS PERMIT REQUIRED CONFINED SPACES

8.3.1 General

Due to the inherent danger of entry into tanks that are permit required confined spaces, the employer (owner/operator and contractor) shall determine the potential hazards prior to the start of work and establish required extraordinary precautionary entry measures and operating procedures. The entry supervisor shall implement these requirements and document them on the entry permit. Prohibited entry limitations shall also be determined and established by the employer (owner/

operator and contractor) and documented on the entry permit by the entry supervisor.

8.3.1.1 Entry supervisors shall issue entry permits for all entry into tanks classified as permit required confined spaces, including, but not limited to, the following:

1. Entry for testing, inspection, tank cleaning, maintenance or hot or safe (cold) work.

2. Casual entry such as breaking the plane of a tank opening (manhole) to conduct visual inspection or testing.

3. Entry upon a roof designated as a permit required confined space to inspect or lower legs.

8.3.1.2 Entry supervisors shall document the requirements for entry and permit cancellation on the entry permit including any necessary extraordinary precautionary measures and operating requirements and procedures.

8.3.1.3 Entry supervisors, qualified persons, entrants, attendants and rescuers shall follow the precautionary measures, procedures and entry limitations required by the permit.

8.3.1.4 Entry supervisors shall require continuous forced air ventilation and periodic or continuous monitoring during entry to ensure that regulatory or facility requirements for air changes per hour and permit limits for hazardous and toxic exposures are maintained.

8.3.1.5 Entry supervisors shall require that entrants use appropriate approved respiratory protection when entering tanks classified as permit required confined spaces.

8.3.1.6 In accordance with the facility confined space program, should the conditions change, the employer (owner/operator or contractor) may reclassify and identify the tank as either a non-permit-required confined space or a non-confined space, depending on the conditions.

8.3.2 Classification as Permit Required Confined Space

8.3.2.1 Employers (owners/operators and contractors) shall classify and identify all tanks that meet the following three requirements as confined spaces:

1. Are large enough and so configured that entrants can enter and work.

2. Have limited or restricted means for entry or exit.

3. Are not designed for or meant to be continuously occupied by employees.

8.3.2.2 Employers shall further classify confined space tanks as permit-required confined spaces if they present additional hazards by having one or more of the following characteristics with the potential to expose entrants to the risk of death, incapacitation, serious injury or illness or impairment of ability to self-rescue (escape unaided from the tank):

1. Tanks that contain or have the potential to contain a hazardous atmosphere.

2. Tanks that contain a material with the potential to engulf an entrant.

3. Tanks that have an internal configuration such that an entrant could become trapped or asphyxiated by inwardly converging walls or by floors that slope downward, tapering to smaller cross-sections.

4. Tanks that contain or have the potential to contain any other recognized serious safety or health hazard.

8.3.3 Entry Requirements for Permit Required Confined Spaces

Entry supervisors shall assure that entry into a tank is classified as "entry into a permit required confined space," whenever any one or more of the following conditions exist (see Section 5 and ANSI/API Recommended Practice 2016 for additional information).

8.3.3.1 Oxygen content of the atmosphere in the tank is less than 19.5% or above 23.5%.

1. It is petroleum industry practice to prohibit entry into tanks when the oxygen levels are above 23.5%, unless there are extraordinary circumstances requiring such entries and employers (owners/operators and contractors) have established and implemented appropriate precautions and safeguards.

2. Entry supervisors shall require periodic or continuous monitoring of oxygen levels while entrants are in permit-required confined spaces to assure that oxygen levels do not exceed 23.5% of atmosphere.

3. Should oxygen levels in the tank differ from those allowed by the permit, entrants shall immediately exit the tank until the cause can be determined and the situation is controlled.

8.3.3.2 Flammable vapor-in-air levels in the tank's atmosphere are above 10% LEL (lower explosive limit) for the hydrocarbon product that was contained in the tank.

1. It is petroleum industry practice to prohibit entry into tanks when the flammable vapor-in air levels are above 10% LEL, unless there are extraordinary circumstances requiring such entries and employers (owners/operators and contractors) have established and implemented appro-

priate precautions and safeguards for permit required confined space entry.

2. Entry supervisors shall require periodic or continuous monitoring of the atmosphere while entrants are in permit required confined spaces to assure that hydrocarbon vapor levels do not exceed 10% LEL.

3. Should hydrocarbon vapor-in-air levels exceed those allowed by the permit, entrants shall immediately exit the tank until the cause can be determined and the exposure is controlled.

8.3.3.3 The potential exists for exposure to an atmospheric concentration of one or more toxic substances at a level that will impair an entrant's ability to self-rescue or entrants are subject to the potential risk of death, incapacity, serious injury or illness due to health effects resulting from toxic exposure.

1. It is petroleum industry practice to restrict entry into tanks when the toxic substances are present at dangerous levels (such as above the PEL) unless there are extraordinary circumstances requiring such entry and appropriate safeguards and precautions are taken.

2. Entry supervisors shall determine if periodic or continuous toxic exposure monitoring is required during entry.

3. Should toxic exposure levels in the tank differ from those allowed by the permit, entrants shall immediately exit the tank until the cause can be determined and the situation is controlled.

8.3.3.4 There is any other potential or existing atmospheric condition that may be "immediately dangerous to life or health" (IDLH).

1. It is petroleum industry practice to prohibit entry into tanks when the atmospheric conditions are IDLH unless there are extraordinary circumstances requiring such entry, the employer (owner/operator or contractor) has established specific entry and safety procedures and appropriate safeguards and precautions are taken.

2. Entry supervisors shall require continuous toxic exposure monitoring during entry under IDLH conditions.

3. Should toxic exposures in the tank exceed those allowed by the permit, entrants shall immediately exit the tank until the cause can be determined and the exposure controlled.

8.3.3.5 There is any physical condition that may result in the entrapment or engulfment of entrants.

1. It is petroleum industry practice to restrict entry into tanks where the potential exists for entrapment or engulfment unless there are extraordinary circumstances requiring such entry and appropriate safeguards and precautions are taken.

2. Entry supervisors shall determine the supplementary rescue equipment and measures that are required during such entry.

3. Should situations develop that are more hazardous than those allowed by the permit, entrants shall immediately exit the tank until the cause can be determined and the controls implemented.

8.3.4 Personal Protection

Employers (owners/operators and contractors) shall evaluate the potential hazards, determine the requirements and designate appropriate protective personal protective equipment and respiratory protection required for entry into permit required confined spaces.

8.3.4.1 Entry supervisors shall assure that testers, entrants, attendants and rescuers wear required protective clothing, personal protective equipment and approved appropriate respiratory protection (such as positive-pressure self-contained breathing apparatus with full facepiece, combination supplied-air respirator with a self-contained breathing apparatus with full facepiece, or approved air purifying respirator) in order to control exposure to the existing and potential atmospheric conditions and hazards and to perform assigned work or activities within the tank.

8.3.4.2 Entry supervisors shall recognize and address the unique hazards presented when issuing permits to enter permit-required confined space tanks that have contained leaded gasoline, lead additives or products containing lead, (and have not been previously cleaned and documented as lead hazard free), and require appropriate testing and protective measures are implemented (see ANSI/API Recommended Practice 2016; ANSI Z88.2; and OSHA 29 CFR 1910.134 for additional information).

8.3.5 Regulatory Requirements

Entry supervisors shall recognize that entry into permit required confined spaces is subject to applicable regulatory requirements. (For example, in the United States, OSHA 29 CFR 1910.146, OSHA 29 CFR 1910.134 and substance specific OSHA regulations require standby personnel for air supply systems and identification of tanks that are permit required confined space). Employers (owners/operators and contractors) shall review the appropriate regulations and determine if any measures in addition to those in the employer confined space program are necessary before entry into a permit required confined space is permitted.

8.3.6 Permit Cancellation

Attendants shall alert entrants and entrants shall immediately leave the tank if hazardous conditions develop within or outside the tank that exceed those authorized by the entry permit or that cause the permit to be cancelled. Entrants shall not reenter the tank until the hazards have abated, the atmosphere within the tank has been retested and reevaluated and the entry supervisor has reissued the cancelled entry permit or issued a new entry permit.

8.4 ENTRY INTO TANKS CLASSIFIED AS NON-PERMIT REQUIRED CONFINED SPACES

8.4.1 General

Employers (owners/operators and contractors) shall determine the potential and existing hazards associated with entry into tanks classified as non-permit required confined spaces prior to the start of work and establish appropriate requirements for entry, hot work and safe (cold) work. The entry supervisor shall implement these requirements and document them on a hot work, safe (cold) work or entry permit prior to allowing entry into the tank.

8.4.1.1 Entry supervisors shall issue appropriate hot work, safe (cold) work and entry permits prior to entry into all tanks that are classified as non-permit required confined spaces. Should the permit conditions change, workers shall leave the tank and the entry supervisor shall reclassify the tank as either a permit-required confined space or a non-confined space, depending on the conditions. The entry supervisor shall then issue new hot work, safe (cold) work and entry permits in accordance with the employer's confined space program requirements before reentry is permitted.

8.4.1.2 All personnel, including entry supervisors, qualified persons, entrants, attendant, workers and rescuers shall follow the precautionary measures, procedures and entry limitations required by the hot work, safe (cold) work and entry permits applicable to their activities.

8.4.1.3 Entry supervisors shall require periodic or continuous monitoring and, if required, continuous forced air ventilation during entry to ensure that regulatory or facility requirements for air changes per hour and safe (cold) work permit conditions are maintained.

8.4.2 Classification as Non-Permit Required Confined Space

Employers (owners/operators and contractors) shall evaluate and may classify confined space tanks as non-permit required confined spaces provided that they meet all of the following requirements:

- The tank meets the atmospheric requirements for a non-permit required confined space (see Section 8.4.3 below).
- The tanks do not contain any material with the potential to engulf an entrant.
- The tanks do not have any internal configurations that could trap or asphyxiate entrants.
- The tanks do not contain or have the potential to contain any other recognized serious safety or health hazards.

8.4.3 Entry Requirements for Non-Permit Required Confined Spaces

Entry supervisors shall evaluate and determine that entry into a tank is "entry into a non-permit required confined space," provided all of the following conditions exist (see Section 5 of this standard and ANSI/API Recommended Practice 2016 for additional information):

8.4.3.1 The oxygen content of the atmosphere in the tank is above 19.5% and below 23.5%.

1. It is petroleum industry practice to prohibit entry into tanks when the oxygen levels are above 23.5%, unless there are extraordinary circumstances requiring such entries and employers (owners/operators and contractors) have established and implemented appropriate precautions and safeguards.

Note: Entry into tanks when the oxygen levels are below 19.5% is entry into a permit-required confined space and shall require the use of air supplied or self contained breathing apparatus.

2. Entry supervisors shall require that a minimum number of air changes per hour are provided so that oxygen levels remain within permit requirements. Supervisors shall require continuous ventilation and periodic or continuous monitoring of oxygen levels while entrants are in tanks to assure that oxygen levels do not exceed 23.5% of atmosphere or fall below 19.5%.

3. Should oxygen levels in the tank differ from those allowed by the permit, the entry supervisor shall cancel the permit and entrants shall immediately exit the tank until the cause can be determined and the situation is controlled.

4. Should the percentage of oxygen in the tank's atmosphere differ from the ambient oxygen percent in the air external to the tank, the entry supervisor shall cancel the permit. Entrants shall exit the tank and a qualified person shall conduct additional testing and evaluations to determine the cause of the difference in oxygen content. This difference could indicate the presence of hazardous atmospheric contaminants or an oxygen source within the tank.

8.4.3.2 For entry and safe (cold) work, flammable (non-toxic) hydrocarbon vapors in air levels in the tank atmosphere are greater than 0%, but below or equal to 10% of the lower explosive (flammable) limit (LEL) for the product that was contained in the tank.

1. Entry supervisors shall reclassify entry into tanks when the flammable vapor-in-air levels are above 10% LEL, as permit-required confined space entry.

2. Entry supervisors shall require periodic or continuous monitoring of the atmosphere while entrants are in non-permit required confined spaces to assure that hydrocarbon vapor levels do not exceed 10% LEL.

3. Should hydrocarbon vapor-in-air levels exceed those allowed by the permit, normally 10% LEL for entry or safe (cold) work, the entry supervisor shall cancel the permit. Entrants shall immediately exit the tank until the cause can be determined, the exposure controlled and the vapor-in-air levels are again at or below 10% LEL and the entry permit is reissued.

4. Entry supervisors or qualified persons issuing permits for hot work in non-permit-required confined spaces, shall assure that the flammable vapor-in-air atmosphere in the tank is not in excess of 0% of the lower explosive (flammable) limit and the oxygen level does not exceed 23.5%. (See Section 12 of this standard for additional information.).

8.4.3.3 Atmospheric concentrations of any toxic substances in the tank are below their PEL/TLV exposure limits as established by applicable regulatory agencies and employer (owner/operator and contractor) policies.

1. Entry supervisors shall determine that entrants will not be subject to the risk of sudden death, incapacity, acute illness or impairment of the ability to self-rescue, injury or illnesses due to health effects resulting from toxic exposure or other potentially harmful atmospheric conditions.

2. Entry supervisors shall require continuous forced air ventilation and periodic or continuous monitoring of the atmosphere to assure that toxic levels do not exceed permit requirements.

3. Should toxic exposure levels exceed those allowed by the permit, the entry supervisor shall cancel the permit and entrants shall immediately exit the tank and shall not return until the cause is determined, the exposures are controlled and the entry permit is reissued.

8.4.4 Personal Protection

Employers (owners/operators and contractors) shall evaluate the potential hazards, determine the requirements and designate appropriate protective personal protective equipment and respiratory protection required to protect entrants from existing and potential atmospheric conditions and physical hazards within the tank, dependent upon the specific work or activities to be performed. Entry supervisors shall assure that entrants wear appropriate protective clothing and equipment and respiratory protection as required by the hot work, safe (cold) work or entry permit.

8.4.5 Regulatory Requirements

Entry supervisors shall recognize that entry into non-permit required confined spaces is subject to applicable regulatory requirements. (For example, in the United States, OSHA 29 CFR 1910.146, OSHA 29 CFR 1910.134 and substance specific OSHA regulations require standby personnel for air supply systems). Employers (owners/operators and contractors) shall review the appropriate regulations and determine if any measures in addition to those required by the employer's confined space program are necessary before entry into a non-permit required confined space is allowed.

8.4.6 Permit Cancellation

Permit supervisors shall assure that the hot work, safe (cold) work or entry permit is cancelled and entrants immediately leave the tank if hazards develop within or outside the tank that exceed the levels authorized by the permit. Entrants shall not reenter the tank until the hazards have been abated, the atmosphere within the tank has been tested, reevaluated and declared to meet the limits established by the employer's confined space program and the hot work, safe (cold) work or entry permit has been reissued.

8.5 ENTRY INTO TANKS CLASSIFIED AS NON-CONFINED SPACES

8.5.1 Classification as Non-Confined Space

Employers (owners/operators and contractors) shall only classify tanks that meet all of the following conditions as non-confined spaces. Should any of these conditions change, the entry supervisor shall immediately reclassify the tank as either a non-permit required confined space or a permit required confined space, depending on the actual or potential conditions.

1. The tank has been cleaned and a qualified person has tested, evaluated and declared the tank to be vapor and toxic free, oxygen levels in the tank's atmosphere are equivalent to ambient and the tank's atmosphere has no potential to expose entrants to hazardous hydrocarbon vapor-in-air mixtures or toxic vapors.

2. The tank does not have restricted or limited entry or exit (for example, plates have been removed or a doorway cut into the side of the tank to provide easy egress).

3. The tank has been isolated, all potential physical hazards in and around the tank have been identified and appropriate protective or precautionary measures have been implemented.

8.5.2 Permit Requirements

Entry supervisors shall determine that there are no existing hazards associated with entry into tanks classified as non-confined spaces prior to the start of work and establish and implement the necessary hot work and safe (cold) work procedures and precautionary measures for potential hazards.

8.5.2.1 Entry supervisors shall issue entry permits for the initial entry into tanks to be classified as non-confined spaces for activities with potentially hazardous exposures. Initial entry shall include, but is not limited to, inspection of the tank and testing of the atmosphere in the tank in order to classify it as a non-confined space prior to starting work or other activities.

8.5.2.2 Qualified persons (permit issuers) shall subsequently issue cold or hot work permits for inspections, work or other operations to be conducted within tanks classified as non-confined spaces.

8.5.3 Entry Requirements

In order for workers to enter tanks classified as non-confined spaces without respiratory protection, the entry supervisor or permit issuer shall determine and indicate on the safe (cold) work or hot work permit that the tanks have no actual or potential atmospheric hazards and that all of the following conditions exist:

8.5.3.1 The oxygen content of the atmosphere inside the tank is essentially equal to the ambient level outside the tank (normally 20.9% oxygen in air).

1. Entry supervisors or permit issuers shall determine whether or not continuous ventilation and periodic or continuous monitoring of oxygen levels are required to assure oxygen levels inside the tank are equivalent to ambient.

2. If the percentage of oxygen in the tank's atmosphere differs from the ambient oxygen percent in the air external to the tank, the entry supervisor or permit issuer shall direct the workers to immediately leave the tank until a qualified person determines the cause of the difference. This difference could indicate the presence of hazardous atmospheric contaminants or an oxygen source within the tank.

8.5.3.2 The flammable vapor-in-air levels in the tank's atmosphere are 0% LEL for any residue or product that was contained in the tank (and not removed from the tank), for any chemicals used to clean the tank, for any solvents used in tank coatings, paint or lining and for any outside vapors that may be introduced into the tank.

1. It is petroleum industry practice not to permit work inside a tank classified as a non-confined space when the flammable vapor-in-air levels are above 0% LEL.

2. If flammable vapor-in-air concentrations rise above 0% LEL, the entry supervisor or permit issuer shall assure that workers exit the tank immediately and shall reclassify the tank as a non-permit required confined space or a permit-required confined space, depending on the actual or potential hazard or exposure.

3. Entry supervisors shall determine whether or not continuous forced air ventilation and periodic or continuous monitoring of the atmosphere is required to assure that hydrocarbon vapor-in-air levels do not exceed 0% LEL.

8.5.3.3 Atmospheric concentrations of toxic substances in the tank are at or below published PEL/TLV limits as established by the employer (owner/operator and contractor) and applicable regulatory agencies, and workers are not exposed to the risk of injury or illnesses due to exposures.

1. Entry supervisors or permit issuers shall determine that workers will not be subject to the risk of sudden death, incapacity, acute illness or impairment of the ability to self-rescue, injury or illnesses due to health effects resulting from toxic exposure or other potentially harmful atmospheric conditions.

2. Entry supervisors or permit issuers shall determine whether or not continuous forced air ventilation and periodic or continuous monitoring of the atmosphere are required to assure that toxic levels do not exceed permit requirements.

3. Entry supervisors or permit issuers shall determine that the tank has not contained leaded gasoline, lead additives or products containing lead or, if it did, it has been cleaned and classified as lead-hazard free.

8.5.3.4 There are no physical hazards inside the tank that could result in the entrapment, engulfment or crushing of workers. Should a situation develop that is more hazardous than anticipated, entry supervisors or permit issuers shall direct workers to immediately exit the tank and not reenter until the cause can be determined and the situation controlled.

8.5.4 Personal Protection

Permit issuers shall assure that workers wear appropriate protective clothing and equipment, as required by the safe (cold) work or hot work permit, while in tanks classified as non-confined spaces.

8.5.5 Permit Cancellation

Entry supervisors or permit issuers shall assure that workers immediately leave the tank if hazards develop within or outside the tank that exceed the exposure levels and condi-

tions authorized by the safe (cold) work or hot work permit, cause the tank to be reclassified to a higher level or if the permit expires or is cancelled for any reason. Workers shall not be permitted to reenter the tank until the hazards have been abated and the atmosphere within the tank has been tested, reevaluated and declared to meet the limits established by the safe (cold) work or hot work permit and the entry supervisor or permit issuer has reissued the permit.

8.6 ENTRY FOR ASSESSMENT OF TANK CONDITION

Entry by qualified persons 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. When tank entry is required to conduct testing inside the tank and to verify atmospheric tests conducted from the exterior of the tank, entry supervisors shall require that the qualified person conducting the testing wear appropriate respiratory protection and personal protective equipment appropriate for entry into permit required confined spaces.

8.6.1 Entry into Out of Service Tanks

Until testing is conducted and a qualified person determines that conditions are safe for entry at other classification levels, entry into tanks shall be considered by entry supervisors and permit issuers as entry into permit required confined space, including, but not limited to, one or more of the following conditions:

- Tanks that were previously cleaned but have been closed and inactive.
- Tanks being cleaned that have been closed overnight or for more than a day.
- Tanks that have been closed for an extended period during the cleaning process, including, but not limited to, shift changes, permit cancellation or facility emergency.

8.6.2 Entry Into Empty Tanks

Entry supervisors and permit issuers shall consider initial entry into an empty tank as permit required confined space entry, including, but not limited to, one or more of the following conditions:

- The empty tank may be void of oxygen due to rusting or inerting.
- 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
- The tank may have a toxic atmosphere from a variety of internal or external sources.

9 Personal Protective Equipment

9.1 PROTECTIVE CLOTHING AND EQUIPMENT

9.1.1 General

Entry supervisors, testers, entrants, attendants, standby persons, rescuers and tank cleaning workers shall wear protective clothing and equipment as required by applicable regulations and the employer (owner/operator and contractor). Personal protection shall be appropriate for the potential hazards, atmospheric exposure, tank conditions and the task, operation or activity to be performed.

9.1.1.1 Employers (owners/operators and contractors) shall provide employees with required tank cleaning protective clothing and protective equipment specific to the tank cleaning operation and other clothing and protective equipment required by regulation or contract.

9.1.1.2 Employees shall provide their own personal protective equipment and work clothing that is normally required for hot work and safe (cold) work including, but not limited to, prescription safety glasses, safety shoes and appropriate clothing, as well as any personal medical devices such as braces and belts.

9.1.2 Selection

Entry supervisors shall evaluate the potential exposures and hazards and determine the personal protection required by entrants, testers, attendants, rescuers, standby persons and workers, including, but not limited to, the following:

9.1.2.1 Impervious clothing, gloves and footwear, to protect the skin, that is specific to the tank cleaning operation. Entry supervisors shall review and understand the potential consequences of using impervious clothing in areas subject to heat stress.

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

9.1.2.3 Fire retardant impervious coveralls or flame resistant clothing or coveralls to protect from a potential flash fire. A determination shall be made at the tank pre-cleaning meeting by the employer (owner/operator) and contractor as to the proper type of protection to be worn by tank cleaning workers and supervisors in facilities with a mandatory requirement for flame resistant or flame retardant protective clothing.

9.1.2.4 Hard hats, head coverings, work gloves, safety shoes and boots, face shields, and goggles to minimize skin and eye exposure to hazardous substances, specifically required for the tank cleaning operation.

9.1.2.5 Entry supervisors shall review and understand the capability of certain clothing materials to generate static elec-

tricity (producing a static discharge) and restrict the use of static generating clothing in areas where the potential for flammable vapor-in-air concentrations exists.

9.1.3 Toxic Contamination

Entry supervisors shall assure that if a tester, entrant, standby person, attendant, rescuer or other worker's skin, eyes, clothing or equipment becomes contaminated with hazardous substances or toxic materials being removed from the tank or used to clean the tank, the appropriate response actions shall be immediately taken. Entry supervisors shall assure that such response includes, but is not limited to, one or more of the following, as required:

- Decontaminating the person by providing necessary personal hygiene and showering.
- Decontaminating and/or disposing of contaminated clothing and equipment.
- Providing required first aid or medical care.
- Determining the extent of exposure and providing any required medical surveillance or testing.

9.1.4 Regulatory Requirements

Employers (owners/operators and contractors), qualified persons and entry supervisors shall be aware of and implement appropriate regulatory requirements and government regulations that are applicable to the use of personal protective equipment. (In the United States, see OSHA 29 CFR 1910.132-6 for additional information.)

9.2 RESPIRATORY PROTECTION

9.2.1 General

Employers (owners/operators and contractors) shall establish and implement proper respiratory protection programs to protect tank cleaning workers from occupational injuries, illnesses, and diseases caused by breathing in air that is contaminated with harmful substances that cannot be controlled by vapor and gas freeing, degassing and ventilation or other methods.

9.2.2 Respirator Selection

Employers (owners/operators and contractors), entry supervisors, and qualified persons shall review all information that is available covering materials contained in the tank or used to clean the tank, including, but not limited to, MSDSs, facility product, sludge and residue information and specific health standards, in order to determine and select appropriate respiratory protection.

9.2.2.1 Employers (owners/operators and contractors) shall provide workers with respirators that are appropriate and suitable for the potential exposures and the purpose intended.

Note: 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.

9.2.2.2 Employers (owner/operators and contractors) 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. (For example, 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.)

9.2.2.3 Entry supervisors shall assure that appropriate respiratory protective equipment is selected, designated and worn by testers, qualified persons, entrants, attendants, rescuers and tank cleaning workers as established by the entry and work permits.

9.2.3 Regulatory Requirements

Employers (owners/operators and contractors), 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.)

9.2.4 Training

Employers (owners/operators and contractors) shall assure that entry supervisors, qualified persons, entrants, standby persons, attendants, rescuers and tank cleaning 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 (owner/operator and contractor).

9.2.5 Respiratory Protection Program

Employers (owners/operators and contractors) shall establish, implement and maintain respiratory protection programs as required by government regulations (in the United States, OSHA 29 CFR 1919.134 covers respiratory protection requirements), industry standards and facility policy. The respiratory protection programs shall include, but are not limited to, the following requirements:

1. Written standard operating 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. Cleaning and disinfecting respirators after each use.

5. Providing 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. A system to determine that tank cleaning workers assigned to tasks requiring the use of respirators are physically able to use the required respiratory protective equipment.

10. Regular reviews and evaluations to determine the continued effectiveness of and updating the respiratory protection program where necessary.

9.2.6 Fitting, Testing, and Checking Respirators

Employers (owners/operators and contractors) shall provide every respirator user with a respirator fitting, including demonstration and practice in the correct way to wear the respirator, its proper adjustment and fit testing instructions to determine that it fits properly.

9.2.6.1 To assure proper protection, the users shall check the face piece fit each time they put on their respirators.

9.2.6.2 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.

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

9.2.7 Breathing Air Cylinders

Employers (owners/operators and contractors) shall require and a qualified person shall verify that breathing air supplied to respirators meets the appropriate regulatory requirements for breathing air (see the specification for Grade D breathing air as described in CGA G-7.1-1966).

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

9.2.7.2 Breathing air cylinders shall be equipped with low level indictors or an alarm system.

9.2.8 Breathing Air Compressors

The use of breathing air compressors shall be allowed only when permitted by the employer (owners/operators and contractors).

9.2.8.1 A qualified person shall inspect and certify that breathing air compressors (or air compressors provided with approved purification system) used to supply breathing air are approved and in good operating condition, in order to ensure breathing air quality.

Note: The contractor shall establish and implement a compressor program and maintain compressor certification, inspection and maintenance records on file for review by the owner/operator.

9.2.8.2 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, but are not limited to, internal combustion engine exhausts, vapors discharged from the tank, vapors emitted from vacuum operations and vapors from nearby tanks during product receipts.

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

9.2.9 Location of Breathing Air Cylinders

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

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

9.2.9.2 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.

9.2.9.3 Standby persons shall immediately notify entrants to switch to emergency bottled air and leave the tank in case of cylinder air supply failure.

9.2.10 Air Supply Lines, Hoses and Couplings

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.

9.2.10.1 Employers (owners/operators and contractors) 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.

9.2.10.2 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.

9.2.10.3 The standby person shall assure that breathing air supply lines, hoses and couplings are not used for supplying anything other than breathing air.

10 Tank Cleaning Personnel

10.1 GENERAL

Tank cleaning personnel include entry supervisors, entrants, attendants and other qualified persons and workers, including, but not limited to, testers, standby persons, vacuum truck operators, tank operators, safe (cold) work and hot work permit issuers, tank cleaning workers, sludge and residue handlers and rescuers.

10.1.1 Responsibilities

Employers (owners/operators and contractors) shall assure that tank cleaning personnel are familiar with employer tank cleaning program requirements and all aspects of tank cleaning operations, including, but not limited to, the following:

1. Are aware of and able to recognize 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 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. Sources of ignition and requirements for bonding and grounding.

10.1.2 Requirements

Employers (owners/operators and contractors) shall assign qualified tank cleaning personnel who are familiar with and will assure compliance with applicable government regulations, industry standards and facility safety procedures.

10.2 ENTRY SUPERVISORS

10.2.1 General

Employers (owners/ contractors) shall assure that entry supervisors are trained and qualified, familiar with the design, configuration, confined space classification and condition of the tanks to be entered, the reasons for the tank entry, the potential hazards and the procedures, controls and requirements for safe entry, hot work and safe (cold) work. Employers (owners/operators and contractors) shall assure and the entry supervisor shall verify that tank cleaning planning, including the required administrative controls, site specific assessments and operations plans and written documentation, is completed, prior to anyone entering the tank.

10.2.2 Responsibilities

Employers (owners/operators and contractors) shall assure that each entry supervisor:

10.2.2.1 Is familiar with and can recognize the actual and potential hazards that may be encountered during decommissioning, tank cleaning and recommissioning 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.

10.2.2.2 Determines the classification and status of the tank, the safe entry requirements and verifies 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.

10.2.2.3 Determines the requirements and frequency for monitoring atmospheric conditions continuously or periodically.

10.2.2.4 Determines the permit and personal protection requirements for testers, standby persons, entrants, attendants and rescuers and indicates these on the 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.

10.2.2.5 Assures when issuing permits, that assigned testers, entrants, standby persons, attendants, workers and employer (owner/operator and contractor) rescuers are qualified persons who are capable of performing their assigned duties.

10.2.2.6 Verifies, by checking and initialing or signing, that all required testing has been conducted, that entry requirements and conditions and all specified entry procedures are satisfied, that the appropriate entries have been made on the permits, and that required equipment is in place before approving the permits.

10.2.2.7 Assures that rescue services are available or qualified employer (owner/operator and contractor) personnel are assigned as rescuers and are available and that attendants are provided with an operable means of summoning rescuers.

10.2.2.8 Prohibits the entry and assures that unauthorized or unqualified persons who may attempt to enter the tank or work area are immediately removed.

10.2.2.9 Determines permit expiration and cancellation criteria and cancels permits upon expiration or whenever conditions change to cause the tank or work area to become more hazardous, terminates entry and directs entrants to immediately evacuate the tank.

10.2.2.10 Assures conditions are reevaluated following entry permit cancellation or expiration and reissues permits in accordance with the initial entry requirements stated therein.

10.2.2.11 Assures 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.

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

10.2.2.13 Performs assigned duties and assures tank cleaning operations are conducted in accordance with the employer's (owner/operator and contractor) confined space program, industry standards, facility procedures and applicable government regulations (see ANSI Z117.1, NFPA 326 and OSHA 29 CFR 1910.134).

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

10.2.2.15 Assures that acceptable entry and tank cleaning operations remain consistent with permit requirements and that permit conditions are maintained whenever responsibility for a tank cleaning activity is transferred to a different person.

10.3 ENTRANTS

10.3.1 General

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

10.3.1.1 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.

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

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

10.3.2 Responsibilities

Employers (owners/operators and contractors) and entry supervisors shall assure that each designated entrant:

10.3.2.1 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.

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

10.3.2.3 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.

10.3.2.4 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.

10.3.2.5 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.

10.3.2.6 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.

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

1. Ordered to exit by the attendant or entry supervisor or by an evacuation alarm.

2. Noticing a potentially dangerous situation or symptom of a stressful condition and hazardous or toxic exposure.

3. Detecting 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.

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

10.3.2.9 Performs duties in accordance with the employer's (owner/operator and contractor) confined space program, facility procedures and applicable government regulations (see ANSI Z117.1, NFPA 326 and OSHA 29 CFR 1910.134).

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

10.4 ATTENDANTS

10.4.1 General

When the tank to be entered is classified as a permit required confined space or a non-permit required confined space, employers (owners/operators and contractors) 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.

10.4.2 Responsibilities

Employers (owners/operators and contractors) and entry supervisors shall assure that each assigned attendant:

10.4.2.1 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.

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

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

10.4.2.4 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.

10.4.2.5 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.

10.4.2.6 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.

10.4.2.7 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.

10.4.2.8 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 while the attendant is on duty and entry is underway:

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 immediately if unauthorized persons have entered or attempted to enter the tank.

10.4.2.9 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.

10.4.2.10 Does not leave the assigned location until properly relieved, even to attempt a rescue.

10.4.2.11 Performs non-entry rescue as specified by the employer's (owner/operator and contractor) 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.

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

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

10.4.2.14 Performs duties in accordance with the employer's (owner/operator and contractor) confined space program, facility procedures and applicable government regulations (see ANSI Z117.1, NFPA 326 and OSHA 29 CFR 1910.134).

10.5 QUALIFIED PERSONS

10.5.1 General

Employers (owners/operators and contractors) shall only assign qualified persons to perform tank cleaning work, including, but not limited to, decommissioning, vapor and gas freeing, degassing, testing, inspection, ventilating, tank cleaning, rescue, sludge and reside removal, repair and maintenance, recommissioning and associated work and activities. Qualified persons include, but are not limited to, supervisors, testers, standby persons, attendants, entrants, vacuum truck operators, tank operators, rescuers, and tank cleaning workers.

10.5.1.1 Qualified persons entering permit required or non-permit required confined spaces to perform any activity shall be considered to be entrants during such entry and shall be subject to all entrant's requirements.

10.5.1.2 Qualified persons and workers entering tanks classified as non-confined spaces shall not be considered to be entrants.

10.5.1.3 Employers (owners/operators and contractors) shall assure that entry and permit supervisors enter the names of all qualified persons and their duties on every entry, safe (cold) work and hot work permit issued.

10.5.2 Responsibilities

Employers (owners/operators and contractors), entry and permit supervisors shall assure that each qualified person:

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

10.5.2.2 Is qualified, trained and physically fit to perform work inside tanks classified as permit required confined spaces, non-permit required confined spaces and non-confined spaces.

10.5.2.3 Knows the actual and potential hazards that may be encountered while working inside a tank, including information on the mode, signs or symptoms, or consequences of exposure of hazardous or toxic substances and are aware of potential behavioral effects of hazardous or toxic exposure on themselves.

10.5.2.4 Communicates with attendants (when attendants are stationed outside the tank) as necessary to enable attendants to monitor the work status and to enable the attendant to alert workers of the need to stop work or evacuate the space.

10.5.2.5 Alerts other workers, assigned attendant and persons who issued the entry or work permits upon recognizing any warning sign or symptom of exposure, noticing any potential hazard or when detecting a prohibited condition.

10.5.2.6 Properly uses tank cleaning equipment, personal protective clothing and equipment and respiratory protection, if required by the entry and work permits.

10.5.2.7 Knows where and how to exit from the tank expediently when:

1. Ordered to exit by an attendant, supervisor or by an evacuation alarm.
2. Noticing a potentially dangerous situation or symptom of a hazardous or toxic exposure.
3. Detecting a hazardous or prohibited condition.

10.5.2.8 Performs no duties that would interfere with their primary assigned duties.

10.5.2.9 Performs duties in accordance with the employer's (owner/operator and contractor) confined space program, facility procedures and applicable government regulations (see ANSI Z117.1, NFPA 326 and OSHA 29 CFR 1910.134).

11 Entering and Working Inside the Tank

11.1 GENERAL

In addition to the requirements in this standard, employers (owners/operators and contractors), entry supervisors and permit issuers shall review appropriate government regulations, industry standards and facility procedures to determine the applicable requirements before issuing permits for entering into and working inside and around tanks. (See API 653, 2009, 2016, 2026, 2027, 2207, 2217A and 2219; ANSI Z117.1; ISGOTT; NFPA 30, 51B, 77and 326; NIOSH Criteria and OSHA 29 CFR 1910.38, 1910.95, 1910.106, 1910.120, 1910.146, 1910.147, 1910.251 and 1910.1200 for additional information).

Permits shall be issued for entry into a permit required 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 operations. Entry supervisors shall assure that entry into the tank and all work performed in and around the tank is conducted in accordance with the employer's (owner/operator and contractor) safe (cold) and hot work permit program and confined space entry permit requirements.

Note: Specific permit requirements are included elsewhere in this standard and the accompanying ANSI/API Recommended Practice 2016.

11.2 ENTRY PERMIT

11.2.1 General

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.

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

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

11.2.1.3 Employers (owners/operators and contractors) shall maintain copies of entry permits on file for at least one year (or longer if required by employer policy or regulation) for analysis and review in order to facilitate appropriate permit program revisions.

11.2.2 Permit Requirements

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

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

11.2.2.2 The purpose of the entry, work to be performed, issue date, time of issue and the authorized duration of the entry permit.

11.2.2.3 The potential hazards of the permit required confined space to be entered and acceptable entry conditions.

11.2.2.4 The 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.

11.2.2.5 The conditions that shall require the permit to be cancelled, 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.

11.2.2.6 The 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.

11.2.2.7 The names of the designated attendants and entrants (and tank cleaning workers assigned to work outside the tank) and the means of communication to be used by entrants and attendants to maintain contact with each other during the entry.

11.2.2.8 The designated facility emergency personnel or outside rescue services 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.

11.2.2.9 Required tank cleaning equipment, including, but not limited to:

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.

11.2.2.10 Any other permits, including, but not limited to, hot work and safe (cold) work permits or work authorizations issued to perform work in or around the tank during entry.

11.2.2.11 Other information whose inclusion is necessary on the permit (given the circumstances of the particular confined space), in order to insure entrant safety, including, but not limited to, the following:

1. Product information such as MSDSs.

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.

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

11.2.2.13 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.

11.2.2.14 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.

11.3 CONTINUOUS FORCED AIR VENTILATION

11.3.1 General

Continuous forced air ventilation shall be provided when entrants are working inside tanks classified as permit required or non-permit required confined spaces. Entry supervisors shall be aware of and institute appropriate ventilation procedures to control exposures so they remain within permit limits during tank entry.

11.3.1.1 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.

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

11.3.2 Vapor and Gas Sources

Entry supervisors, testers, entrants 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:

11.3.2.1 Low spots on tank floors, in sumps and holes and beneath leaking tank bottoms.

11.3.2.2 Inside of double walls and double bottoms of tanks.

11.3.2.3 Inside columns, roof supports, fire foam systems, pontoons, floating swing lines, roof drains, internal piping, and heating coils.

11.3.2.4 Saturated in flotation and insulation materials, or in rust, residue and other accumulations on internal tank surfaces.

11.3.2.5 Between primary and secondary seals on floating roof.

11.3.3 Potential Hazards

Entry supervisors shall review the potential hazards associated with tank cleaning during forced air ventilation and indicate the requirements for safe operations and personal protective equipment on the entry permit. Entry supervisors, testers, attendants, entrants and workers shall also consider additional hazards that may be present in tanks during ventilation, including, but not limited to, the following:

11.3.3.1 The need for continuous wetting or washing of exposed surfaces when the potential for pyrophoric iron sulfide deposits exists.

11.3.3.2 The need for continued use of self contained or air supplied respiratory protection while cleaning tanks that contain (or are suspected of having contained) leaded gasoline, lead additives or products containing lead until such tanks are cleaned, dried, tested and declared lead free.

11.4 TANK SAFE (COLD) WORK, MAINTENANCE AND REPAIRS

11.4.1 Safe (Cold) Work Permits

Permit supervisors shall issue permits for safe (cold) work inside tanks, including, but not limited to, spraying, painting, maintenance, repair, installing liners, and construction.

11.4.1.1 If the work is to be performed in a tank that is classified as a permit required confined space or a non-permit required confined space, an entry permit shall be issued by an entry supervisor.

11.4.1.2 Permit supervisors shall assure that the safe (cold) work permit requires compliance with all of the conditions and requirements of this standard, applicable government regulations and facility procedures.

11.4.2 Protection from Hazards

Entry or permit supervisors shall determine the potential hazards involved with safe (cold) work inside tanks and assure that appropriate requirements are indicated on the safe (cold) work permits.

11.4.2.1 Supervisors shall assure that tanks cleaning workers follow all permit requirements to protect against flammable, toxic or other harmful atmospheres and maintain safe (cold) working conditions.

11.4.2.2 Entry supervisors shall recognize that entry into all tanks classified as confined spaces or non-confined spaces, to perform certain types of repair, maintenance and tank cleaning work, requires specific safe (cold) work procedures and safe (cold) work permits.

11.4.2.3 Entry supervisors shall determine the personal protection appropriate to the entry. The appropriate personal protective clothing, equipment or respiratory protection depends on the work to be performed, the substances, concentrations and circumstances involved and other work being conducted in the area at the same time,

11.4.2.4 The requirements for safe (cold) work and entry shall be evaluated and determined by the employer (owner/operator and contractor) during the planning phase of the tank cleaning operation.

11.5 UNDESIRABLE PRODUCT, SLUDGE, AND RESIDUE DISPOSAL

Employers (owners/operators and contractors) 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 (owner/operator and contractor) procedures.

Note: Employers (owners/operators and contractors) shall be aware of exemptions that may be applicable to disposal of certain hazardous materials.

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 (see API Recommended Practice 2016 and API 2219; OSHA 29 CFR 1910.120; DOT 49 CFR 171-180; and EPA 40 CFR 260-271 for additional information).

12 Hot Work and Tank Repairs

12.1 GENERAL

Hot work is any work that has the potential to produce enough energy to be a source of ignition in an area where the potential for a flammable vapor-in-air atmosphere exists. Examples of hot work associated with tank cleaning include, but are not limited to, welding, cutting, burning, grinding, drilling, heating, spray washing, steam cleaning, vacuum truck operations, abrasive blasting, and use of internal combustion engines and non-explosion proof or improperly classified electric equipment.

12.1.1 Hot Work Program

Employers (owners/operators and contractors) 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.

12.1.2 Hot Work Requirements

Entry supervisors and hot work permit issuers shall assure that hot work operations inside of tanks complies with all of the requirements of this standard, applicable government regulations and facility procedures for safe entry and work inside tanks (see ANSI Z49.1; API 653, 2009, 2016, 2027, 2202 and 2207; NFPA 51B; and OSHA 29 CFR 1910.251 for additional information).

12.2 HOT WORK PERMITS

12.2.1 Permit Issuance

Qualified persons shall issue hot work permits for hot work in or around any tank, regardless of the classification of the tank. Entry supervisors shall issue entry permits (in addition to the hot work permits) before hot work is allowed to begin inside tanks classified as permit required confined spaces or non-permit required confined spaces, or in non-confined spaces where the hot work has the potential to change the classification of the tank, so that an entry permit is required.

12.2.2 Permit Conditions

Hot work permit issuers shall determine the potential hazards and assure that appropriate controls and precautions are taken to protect entrants and workers from flammable and toxic vapors, toxic fumes and other harmful exposures when hot work is conducted inside tanks, outside of tanks and in the vicinity of tanks. Entry supervisors and qualified persons issuing hot work permits shall:

12.2.2.1 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.

12.2.2.2 Specify the requirements for any local exhaust ventilation, types of respiratory protection and/or atmospheric exposure monitoring on the entry and hot work permits.

12.2.2.3 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.

12.2.3 Permit Requirements

During hot work operations, entry supervisors or qualified persons issuing hot work permits 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 that the permitted exposure limits for toxic vapors, fumes and substances are not exceeded.

12.2.3.1 Qualified persons issuing hot work permits for work in tanks classified as permit required confined spaces or non-permit required confined spaces shall assure that ventilation is continued during hot work to minimize any accumulation of flammable and toxic vapors or toxic fumes emanating from such sources.

12.2.3.2 Qualified persons issuing hot work permits 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) in tanks classified as permit required and non-permit required confined spaces.

12.2.3.3 Qualified persons issuing hot work permits shall determine if periodic or continuous atmospheric monitoring is required when hot work operations are conducted in tanks classified as permit required confined spaces, non-permit required confined spaces and non-confined spaces in order to assure that permit limits are not exceeded.

12.2.3.4 Qualified persons issuing hot work permits shall determine if there is a need for ventilation, either general or local, when hot work operations are conducted in tanks classified as non-confined spaces.

12.3 HOT WORK HAZARDS

12.3.1 General

The entry supervisor or qualified person 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.

12.3.1.1 The entry supervisor or qualified person issuing the hot work permit shall require that any tank surfaces to be heated. including, but not limited to, 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.

12.3.1.2 The entry supervisor or qualified person issuing the hot work permit shall determine the quantity and potential composition of fumes generated during hot work by investigating the materials being welded or worked on including, but not limited to, any deposits, residue, coatings, or paint being heated or burned and the products of combustion of welding rods.

12.3.2 Hazard Awareness

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

12.3.2.1 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.

12.3.2.2 Flammable and toxic liquids and vapors may enter a tank through leaks in the tank bottom or may evolve from other spaces including, but not limited to, pipe-column roof supports, chambers, swing lines, pontoons, and sumps.

12.3.2.3 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 floor. (See API 2207 and 2009 for additional guidance on repairing tank bottoms.)

12.3.2.4 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.

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

12.3.2.6 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.

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

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

12.3.3 Equipment Hazards

The qualified person issuing the permit shall be aware of potential hazards associated with the use of hot work equipment and establish safe (cold) work procedures, including, but not limited to, the following:

12.3.3.1 Prohibit oxygen, flammable gas and inert gas cylinders from being taken into tanks classified as permit required or non-permit required confined spaces.

12.3.3.2 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.

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

12.4 HOT WORK IN LEADED SERVICE TANKS

12.4.1 General

Preparatory to hot work, the entry supervisor shall issue a permit to enter a tank that has been in leaded service only after the tank has been tested and declared lead-in-air free.

12.4.2 Hot Work Permit

In addition to the requirement for an entry permit, a qualified person shall issue a hot work permit to conduct hot work inside or around a tank that has been in leaded service.

12.4.2.1 The qualified person issuing the hot work permit shall require that surfaces of tanks that have been in contact with leaded gasoline, lead additives or products containing lead be cleaned, scraped or wire brushed down. The qualified person shall assure that bare metal covers an area at least 12 inches (30 centimeters) surrounding any area that may be subject to excessive heat exposure from welding or other hot work operations.

12.4.2.2 The qualified person issuing the hot work permit shall 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 in these tanks.

12.4.2.3 The qualified person issuing the hot work permit shall consider the potential for organic lead vapors to be released from rust, residue and deposits and require that workers use appropriate respiratory protection during cleaning and hot work.

12.4.2.4 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.

12.5 FIRE PREVENTION

12.5.1 General

When hot work is permitted inside a tank, entry supervisors and qualified persons issuing hot work permits 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.

12.5.2 Employee Use of Equipment

Employers (owners/operators and contractors) shall assure that employees are instructed in the use of the incipient fire protection equipment provided.

13 Emergency Planning

13.1 EMERGENCY RESPONSE PLAN

Employers (owners/operators and contractors) shall develop and implement an emergency response plan that includes procedures for rescue of entrants in the event that an emergency occurs within the tank or an emergency occurs within the vicinity of the tank or elsewhere within or outside of the facility, that impacts on tank entrants.

13.1.1 Plan Elements

13.1.1.1 The plan shall consider emergencies including, but not limited to, hazardous and toxic exposures in excess of permit limits, entrant injury or illness, entrant entrapment, fires and explosions, flammable and toxic liquid, vapor or gas releases and other emergencies from sources external and internal to the tank.

13.1.1.2 The plan shall be tank specific and include, but not be limited to, procedures for summoning rescuers and other emergency responders and conducting rescue of entrants from tanks being cleaned that are classified as permit required and non-permit required confined spaces.

13.1.1.3 The plan shall identify the specific rescuers, including, but not limited to, the following:

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. The entrant's capability for self-rescue.

13.1.2 Employer Responsibilities

Employers (owners/operators and contractors) shall assure that tank cleaning supervisors, permit issuers, attendants, entrants and workers know the procedure and have a means of communication to summon assistance in event of an emergency. Employers shall designate tanks and 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.

13.1.3 Employee Responsibilities

Employees shall be aware of their responsibility to immediately stop work and vacate the tank upon indication or an emergency or notification from an attendant. Supervisors, permit issuers, attendants, entrants and workers shall be aware of emergency procedures. Entrants and attendants shall have and know how to use the provided means of communication to summon assistance in event of an emergency. Entrants shall be aware of 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.

13.2 OUTSIDE RESCUE SERVICES

13.2.1 Evaluation of Rescue Service

When tank cleaning involves tanks classified as permit required or non-permit required confined spaces, employers (owners/operators and contractors) 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.

13.2.2 Selection of Rescue Service

Employers (owner/operators and contractors) shall base their selection of a specific rescuer on criteria including, but not limited to, the following items:

13.2.2.1 The rescue service's experience, equipment and capability.

13.2.2.2 The rescue service's proficiency with tank rescue related tasks and use of equipment.

13.2.2.3 The rescue service's training and ability to function appropriately during rescue activities.

13.2.2.4 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.

13.2.3 Employer Requirements

Employers (owners/operators and contractors) shall provide the designated rescue service with appropriate information and access, including, but not limited to the following:

13.2.3.1 Advise rescue services of the potential atmospheric and physical hazards to be expected during a rescue, including providing copies of MSDSs and other information available for the material in the tank.

13.2.3.2 Provide 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.

13.3 EMPLOYER (OWNER/OPERATOR AND CONTRACTOR) RESCUERS

In lieu of relying upon outside rescue services, employers (owners/operators) may designate an on-site trained and qualified facility emergency response brigade to be responsible to respond to tank cleaning emergencies and conduct rescue operations. Alternately, a contractor may decide to designate employees to provide tank rescue and emergency services for tank cleaning operations. The decision as to whether the owner/operator or the contractor will be responsible for rescue services shall be made at the time of the contract negotiations. The specific duties of designated facility responders, contractor rescuers and outside rescue services shall be established during the tank pre-cleaning meeting.

13.3.1 Facility Emergency Response Brigades

Owners/operators providing rescue services shall assure that facility emergency response brigade personnel are trained and qualified in tank rescue, including, but not limited to, the following items:

13.3.1.1 Providing general rescue and confined space entrant training and documenting responder proficiency in accordance with the training requirements of this standard.

13.3.1.2 Training designated responders in basic first aid and cardiopulmonary resuscitation (CPR) and assuring that at least one responding rescuer is currently certified in CPR and first aid.

13.3.1.3 Providing appropriate personal protective clothing, respiratory protection and rescue equipment required for tank rescue and entry and training responders in its use.

13.3.1.4 Informing responders of potential atmospheric and physical hazards to be expected during a rescue, including copies of MSDSs and other information available on material in the tank.

13.3.1.5 Providing access to the tank to be cleaned so responders can preplan rescue operations.

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

13.3.1.7 Assuring 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.

13.3.2 Contractor Emergency Responders

Contractors who have the responsibility to provide rescue services for tank cleaning operations involving tanks classified as permit or non-permit required confined spaces, may decide to either provide an approved outside rescue service or designate employees rescuers who are trained and qualified in tank rescue, including, but not limited to, the following items:

13.3.2.1 Contractors shall provide rescue training to designated employees, including entrant training and document employee proficiency in accordance with the training requirements of this standard.

13.3.2.2 Contractors shall train designated rescuers in basic first aid and cardiopulmonary resuscitation (CPR) and assure that at least one assigned rescuer is currently certified in CPR and first aid.

13.3.2.3 Contractors shall provide designated rescuers with appropriate personal protective clothing, rescue equipment and respiratory protection required for tank rescue and entry and train rescuers in the use of this protection and equipment.

13.3.2.4 Contractors shall inform designated rescuers of the potential atmospheric and physical hazards to be expected during a rescue, including providing rescuers with copies of MSDSs and other information available on the material in the tank.

13.3.2.5 Contractors shall assure the owners/operators provide access to the tank to be cleaned so that the rescuers can prepare emergency plans and preplan rescue operations.

13.3.2.6 Contractors shall assure that designated rescuers practice confined space rescues at least once every 12 months using simulated operations in which dummies, manikins or persons are removed from actual tanks or confined spaces representative of the types of tanks to be cleaned.

13.3.2.7 Contractors shall assure that designated rescuers are aware of the potential hazards when attempting to remove an entrant from the tank by use of the retrieval line from outside the tank and take appropriate precautions.

13.4 RESCUE EQUIPMENT

13.4.1 General

To facilitate non-entry rescue whenever entry into a tank classified as a permit-required confined space occurs, 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.

13.4.2 Retrieval Equipment

When retrieval equipment is required, employers (owners/operators and contractors) shall provide approved retrieval systems and equipment meeting applicable government requirements (for example, in the United States, OSHA 29 CFR 1910.146) or industry standards, including, but not limited to, the following:

13.4.2.1 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.

13.4.2.2 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.

13.4.2.3 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 feet in depth.

13.4.3 Special Equipment

Employers (owners/operators and contractors) and entry supervisors shall recognize the potential hazards involved

in 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, facility responders or contractor rescuers shall provide the special rescue equipment needed when descent is made onto floating roofs of tanks in service, including, but not limited to the following:

13.4.3.1 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.

13.4.3.2 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 feet in depth.

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

13.5 OTHER EMERGENCIES

Employers (owners/operators and contractors) shall assure that their emergency plans address other potential tank cleaning 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.

13.6 MEDICAL EMERGENCIES

Employers (owners/operators and contractors) shall develop plans for medical emergencies similar to those for rescue, fire, and other emergencies.

13.6.1 Medical Information

Where the potential exists for any worker who is injured or taken ill during the tank cleaning operation to be exposed to a hazardous or toxic substance, employers (owner/operators and contractors) shall assure that copies of MSDSs 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.

13.6.2 Medical Facilities

Employers (owners/operators and contractors) 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.

14 Recommissioning

14.1 GENERAL

14.1.1 Recommissioning Plans and Procedures

In order to return the tank to service (recommissioning), employers (owners/operators and contractors) shall develop and implement plans and procedures similar to those used to remove the tank from service (decommissioning) (see ANSI/API Recommended Practice 2016 for additional information).

14.1.2 Regulatory Requirements

Employers (owners/operators and contractors) 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 (see API 653 and EPA 40, 260-271for additional information).

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

14.1.2.2 Regulatory requirements prior to recommissioning include, but are not limited to, hydrostatic testing, seal inspection and visual inspection for leakage.

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

14.2 RECOMMISSIONING PREPARATION

14.2.1 General

The employer (owner/operator and contractor) shall assure that operations elsewhere in the facility do not subject any part of the recommissioning process to hazardous conditions.

14.2.2 Tank Inspection and Closing

Employers (owners/operators or contractors) shall designate a qualified person to thoroughly inspect the tank prior to the reinstallation of tank opening (manhole) covers including, but not limited to, the following items:

Note: An inspection satisfying the requirements of API 653 shall be considered a qualified inspection.

14.2.2.1 Conduct a check and verify that all entrants and workers have exited the tank.

14.2.2.2 Inspect and verify that all tank cleaning repair and maintenance equipment, tools, materials and debris have been removed from inside the tank.

14.2.2.3 Check and verify that all internal connections and appurtenances have been reconnected or attached.

14.2.2.4 Assure that the tank inspection and verification results are entered on the entry permit.

14.2.3 Reactivating Isolated Equipment

Employers (owner/operators and contractors) shall assign qualified persons to reactivate all equipment, piping and appurtenances that were deactivated or isolated when the tank was decommissioned, including, but not limited to, the following items:

14.2.3.1 Employers (owners/operators or contractors) 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.

14.2.3.2 Employers (owners/operators or contractors) shall provide new approved gaskets, flanges and bolts for reconnecting piping, equipment and tank opening (manhole) covers.

14.3 REFILLING TANKS

14.3.1 General

Employers (owners/operators and contractors) 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 (owner/operators or contractors) 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.

14.3.2 Initial Fill Rate

Employers (owners/operators and contractors) shall assure that the initial flow rate (velocity) of product into the tank is at a reduced rate until the inlet opening of the fill line is covered with liquid, in order to minimize the creation of static electricity. The initial fill velocity will vary depending on the product, pump capacity, size of the fill line and tank configuration, but should be not more than 3 feet (1 meter) per second (see API 2003 and ISGOTT for additional information).

14.3.3 Filling Floating Roof Tanks

When crude petroleum or petroleum products are pumped into empty floating-roof tanks, the vapors occupying the space between the liquid surface and the floating roof are usually expelled from under the floating roof into the atmosphere immediately above the floating roof. Due to the potential for a flammable vapor-in-air atmosphere to exist in these spaces during the filling of floating roof tanks, employers (owners/operators and contractors) shall review this refilling activity and develop and implement proper precautionary measures, recommended initial fill rates and safe operating procedures, including, but not limited to, the following:

14.3.3.1 Employees shall observe the precautions concerning pumping rates and prevention of splashing to prevent static generation and to minimize vapors when filling either external floating roof tanks or internal floating-roof tanks, until the roofs are floating.

14.3.3.2 Employers (owners/operators and contractors) shall establish procedures that require significant reduction of fill rates as product nears the pontoons and/or lower deck surfaces of floating roofs as damage might result (especially to roofs made of aluminum) if the liquid rises too fast.

14.3.3.3 Employers shall establish safe procedures for filling tanks in accordance with industry standards including, but not limited to, filling rates to reduce static generation, overfill protection and the possibility of emitting vapors during lightning storms.

14.4 SAMPLING AND GAUGING TANKS

14.4.1 Requirements

Employers (owners/operators) shall develop and implement safe operating procedures for sampling and gauging tanks after recommissioning, including, but not limited to, the following:

14.4.1.1 Employers (owners/operators) 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.)

14.4.1.2 Employers (owners/operators) 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 a period of at least 18 hours after the tank has been filled and the roof refloated.

14.4.1.3 Employers (owners/operators) shall assure that gauging and sampling operations are not performed when a lightning storm is imminent or in progress.

14.4.2 Testing

Testing shall be conducted to assure 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 where conditions and exposure levels are potentially hazardous (see API 2026 for additional information).

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

14.4.2.2 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.

14.5 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. To reduce the chance of ignition, employers (owners/operators and contractors) 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.

15 Training

15.1 GENERAL

Employers (owners/operators and contractors) shall assure that all entry supervisors, entrants, 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.

15.1.1 Training Requirements

Employers (owners/operators and contractors) shall assure that employees have been trained or educated and retrained or re-educated, as follows:

15.1.1.1 Prior to beginning the initial assignment to their work or duties.

15.1.1.2 Before a change in assignment to a different type of work or duties.

15.1.1.3 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.

15.1.1.4 Whenever the employer (owner/operator and contractor) 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.

15.1.2 Training Verification

Employers (owners/operators and contractors) 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.

15.2 QUALIFICATION

Employers (owners/operators and contractors) shall assure that all employees engaged in tank cleaning activities, have the understanding, knowledge and skills and are able to safely perform their assigned duties.

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