

# Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service

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# **Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service**

**Health and Environmental Affairs Department  
Safety and Fire Protection Subcommittee**

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## FOREWORD

This publication is intended to provide information associated with safe access/egress involving floating roofs of tanks in petroleum service. This publication includes a discussion of the common hazards associated with these operations and the appropriate precautions for preventing accidents and injuries.

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Suggested revisions are invited and should be submitted to the director of the Health and Environmental Affairs Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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# Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service

## 1 Scope and Objectives

### 1.1 SCOPE

**1.1.1** This publication addresses the hazards associated with access/egress onto open-top, covered open-top and internal floating roofs of in-service petroleum storage tanks and identifies some of the most common practices and procedures for safely accomplishing this activity.

**1.1.2** This publication is intended primarily for those persons who are required to perform inspection, service, maintenance or repair activities that involve descent onto floating roofs of in-service petroleum tanks.

**1.1.3** This publication does not cover general considerations that apply to climbing onto petroleum storage tanks and other structures, including, but not limited to: (a) slippery or ice-covered stairways and walkways, (b) access during electrical storms, and (c) access during emergency conditions (such as to extinguish a fire or cover exposed product with foam). This publication may not apply to daily or routine tasks of tank gaugers and other personnel involved in non-permit confined spaces; however, such persons shall be trained and shall be made aware of the potential hazards described herein.

**1.1.4** Preparations and precautions for entering petroleum storage tanks that have been removed from service for cleaning are covered in API Standard 2015.

### 1.2 OBJECTIVES

**1.2.1** This publication has the following objectives:

- a. To identify the potentially hazardous conditions associated with access/egress onto open-top, covered open-top and internal floating roofs of storage tanks while the tanks are in petroleum service.
- b. To establish general precautionary measures appropriate to individual situations.

## 2 Referenced Publications

The following documents are referenced in this publication:

### API

Std 650	<i>Welded Steel Tanks for Oil Storage</i>
Std 2015	<i>Safe Entry and Cleaning of Petroleum Storage Tanks</i>
Publ 2027 <sup>1</sup>	<i>Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service</i>

<sup>1</sup>Publ 2027, 2nd Edition, 1988 can be ordered from Global Engineering Documents, 15 Inverness Way, East, P.O. Box 1154, Englewood, CO 80150-1154.

### NFPA<sup>2</sup>

NFPA 70	<i>National Electrical Code</i>
NFPA 325M	<i>Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids</i>

### OSHA<sup>3</sup>

<i>Code of Federal Regulations (OSHA 29 CFR)</i>	
1910.134	<i>Respiratory Protection Standard</i>
1910.146	<i>Permit-Required Confined Spaces General Industry Standard</i>
1910.1000	<i>Subpart Z, Toxic and Hazardous Substances</i>

## 3 Definition of Terms

Terms that are used in this publication are defined in 3.1 through 3.17.

**3.1 air-supplied respiratory protection:** A respirator that provides a supply of safe breathing air from a tank (either a self-contained breathing apparatus portable tank or an air line supply tank) or from an uncontaminated fresh air supply source located outside of the work area.

**3.2 cold work:** Work activity that does not produce heat, sparks or other forms of energy sufficient to provide an ignition source if a vapor air mixture in the flammable range is present.

**3.3 confined space (as defined by OSHA):** A space that (a) is large enough and so configured that a worker can bodily enter and perform assigned work, (b) has limited or restricted means of entry or exit, and (c) is not designed for continuous occupancy by workers.

a. *Permit-required confined space*, as defined by OSHA, is a space which meets the confined space requirements and also has one or more of the following 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, or (4) contains any other recognized serious safety or health hazard(s).

b. *Permit-required confined space program (Permit Space Program)* is the facility's (employer's) overall program for controlling and regulating entry into permit-required confined spaces and, where appropriate, protecting employees from permit space hazards.

c. *Non-permit confined space* means a confined space that does not contain or, with respect to atmospheric hazards, have

<sup>2</sup> National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

<sup>3</sup>U.S. Occupational Safety and Health Administration. OSHA publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.



the potential to contain any hazard capable of causing death or serious physical harm.

**3.4 entry:** Any work activity involving entry onto a floating roof. *Entry* occurs as soon as any part of an entrant's body goes past the top of the tank preparatory to descent upon the floating roof.

a. *Attendant* is a trained and qualified person stationed outside a permit-required confined space to monitor the entrants and perform attendant duties in accordance with the facility's *Permit Space Program*.

b. *Entrant* is a person who is trained, qualified, and authorized to enter permit-required confined spaces.

c. *Entry supervisor* is a person who by training and experience is qualified and authorized to allow entry for work in permit-required and non-permit-required confined spaces and who is familiar with the tasks to be performed, the potential hazards that may be encountered in the confined space, the safety and health requirements for work in the confined space and the facility's *Permit Space Program*. Designated *Entry Supervisors* are responsible to determine that acceptable permit-required confined space entry conditions are present and met; to authorize entry into permit and non-permit-required confined spaces; to assign or act as required *testers*, *entrants*, *attendants* and *rescuers*; to oversee entry operations; and to terminate entry as required.

d. *Tester* is a person who is trained and qualified to operate, calibrate and adjust instruments, and conduct appropriate atmospheric testing. When descending upon floating roofs to conduct testing, the *tester* then becomes an *entrant*. A *tester* or an *entrant* can also be an *entry supervisor*.

**3.5 exposure limit:** The maximum airborne concentration limits for toxic substances to which workers may be safely exposed for a prescribed time without protection (i.e., respiratory protection). *Exposure limits* are usually expressed in parts per million or milligrams per cubic meter, averaged for a prescribed time, e.g., 15 minutes, 8 hours. They may also be expressed as ceiling limits, which should not be exceeded. Material safety data sheets (MSDSs) available from employers, manufacturers or suppliers of the material should identify recommended *exposure limits* of the product stored in the tank.

a. *Permissible Exposure Limits (PELs)* are exposure limits established in the Occupational Safety and Health Administration, U. S. Department of Labor regulations and are those found in the most current editions of OSHA 29 CFR 1910.1000 and chemical specific standards.

b. *Hazardous atmosphere* is an atmosphere which may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue, injury, or acute illness from (1) flammable gas, vapor or mist in excess of 10% LFL, (2) airborne combustible dust at a concentration that meets or exceeds its LFL, (3) atmospheric oxygen concentration below

19.5% or above 23.5%, (4) atmospheric concentration of any substance in excess of its permissible exposure limit, and (5) any other atmospheric condition which is immediately dangerous to life or health.

Note: OSHA Standards, MSDSs, facility documents and other published information may be used to provide guidance for acceptable atmospheric exposure limits for vapors and toxic contaminants.

**3.6 flammable vapor limit:** The concentration of vapor in normal air which will ignite upon contact with a source of ignition.

Note: Flammable vapor limits will be extended in oxygen-enriched atmospheres. The following definitions for LFL and UFL are based on definitions of flammable vapor limits given in NFPA 325M.

a. *Lower Flammable Limit (LFL)* is the minimum concentration of a vapor in air below which propagation of flame does not occur on contact with an ignition source and is generally considered to be "too lean to burn." *LFL* is usually expressed as a volume percentage of the vapor in air.

b. *Upper Flammable Limit (UFL)* is the maximum concentration of a vapor in air above which propagation of flame does not occur upon contact with an ignition source and is generally considered to be "too rich to burn." *UFL* is usually expressed as a volume percentage of the vapor in air.

**3.7 floating roof, open-top:** The cover which floats upon the top of the product stored inside an open-top floating roof storage tank. It is usually constructed of steel or aluminum and may be designed as a pontoon-type, pan type with solid buoyant material, or a combination of both types. *Open-top floating roofs* are normally equipped with roof drains to remove water, seals (primary or both primary and secondary) to prevent vapor releases, vents and other appurtenances, and adjustable stairways or ladders for access from the top of the tank onto the *open-top floating roof*. (See Figure 1.)

**3.8 floating roof, internal:** The buoyant deck, raft or internal floating cover of a cone (fixed) roof storage tank. An *internal floating roof* may be constructed of various types of metal, plastic, or metal-covered expanded plastic foam. Its construction may be of the honeycomb panel, pontoon- or pan-type, solid buoyant material, or a combination of these. *Internal floating roofs* are usually equipped with seals to prevent vapor releases and with ladders which provide access from the top of the cone roof onto the *internal floating roof*. (See Figure 2.)

**3.9 floating roof, covered open-top:** The floating roof inside a tank which was once an open-top floating roof tank but which is a tank now covered by a geodesic dome or other weather-protective device. The floating roof is usually constructed of various types of metal and designed as a pontoon- or pan-type with solid buoyant material or a combination of both. *Covered open-top floating roofs* are usually provided with seals to prevent vapor releases, vents and other appurtenances, and adjustable stairways or ladders for access onto

the floating roof. The roof drains formerly used to remove water may be deactivated and sealed. (See Figure 3.)

**3.10 floating roof tank:** Any above-ground vertical atmospheric storage vessel that is equipped with a floating roof and that contains a petroleum feedstock, an intermediate stock or a finished product.

- a. *Floating roof* is a moveable cover which floats on top of the product in a floating-roof tank.
- b. *In-service floating roof tank* is a tank that contains a quantity of petroleum product that could cause a flammable, oxygen-deficient or toxic atmosphere above the floating roof.

**3.11 hot work:** Work activity which has the potential to produce heat, sparks, or other forms of energy sufficient to provide an ignition source should a vapor air mixture in the flammable range occur.

**3.12 inerting:** The displacement of the potentially flammable atmosphere in the permit space by a non-combustible gas such as nitrogen, so that the resulting atmosphere is non-combustible.

Note: Inerting also produces an oxygen-deficient atmosphere.

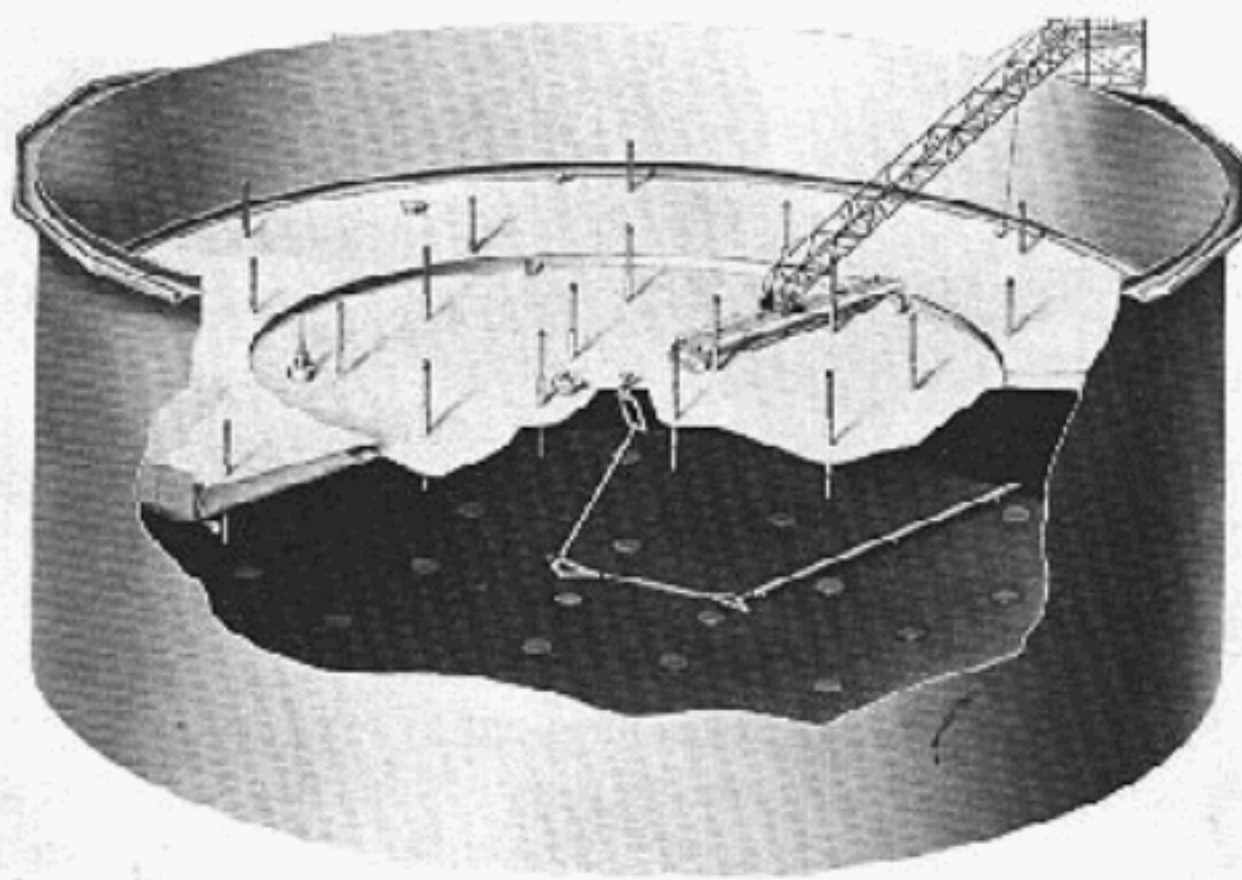


Figure 1—Open-Top Floating-Roof Tank



Figure 2—Internal Floating Roof

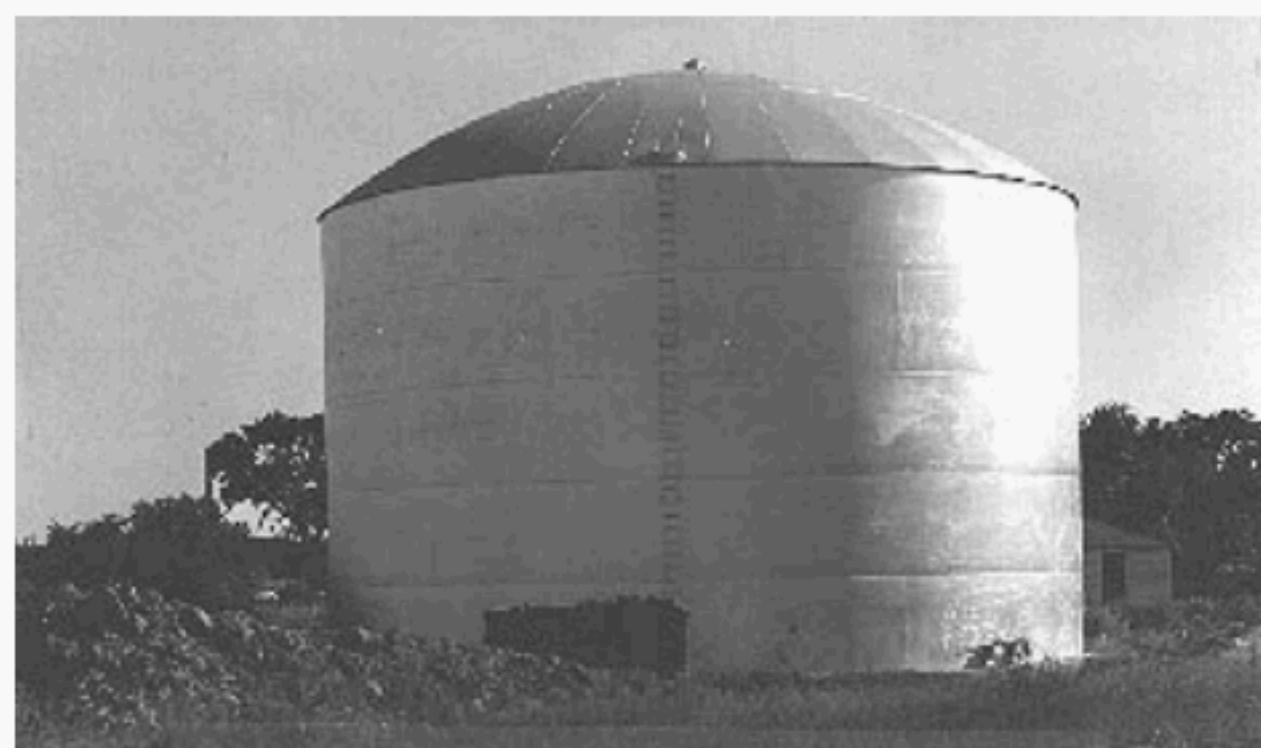


Figure 3—Umbrella-Roof Tank

**3.13 lockout/tagout:** The condition when switches are open (in the de-energized position) and locked out, and/or mechanical linkages are set, tagged, and sealed or locked to preclude the input of product or energy such as that required for mixing or heating, into the tank.

**3.14 permit:** The written authorization required by the facility's *permit system*.

- a. *Permit system* is the employer's written procedure for preparing, issuing, and administering permits to conduct hot work, enter permit-required confined spaces and perform other permit-required activities, and for returning the permit space back to service following completion of work.
- b. *Entry permit* is a written authorization required by the *Permit Space Program* and issued by the *entry supervisor* to allow and control entry into *permit-required confined spaces*.
- c. *Hot work permit* is the written authorization required by the facility's *permit system* to conduct *hot work*.
- d. *Work permit* is the written authorization required by the facility's *permit system* to conduct *cold work*.

**3.15 roof position:** The position of the floating roof in respect to the top and bottom of the tank.

- a. *High roof position* is the position attained when the floating roof is 8 feet (2.4 meters) or less below the maximum design tank shell elevation.
- b. *Low roof position* is the position attained when the floating roof is 8 feet (2.4 meters) or less above its minimum design elevation.
- c. *Out of flotation* refers to the condition of a floating roof when the liquid level is not high enough to float the roof and when all or part of the floating roof is resting on its support system.

**3.16 static condition:** When the floating roof is not moving as the tank is neither receiving nor discharging product and the mixers (if any) are not operating.

**3.17 tank isolation:** The condition that exists when all lines and valves are closed (for example, the valves are locked or sealed and tagged, or the lines to and from the tank are dis-



connected and blinded, blanked, or double-blocked, and bled as necessary) to preclude the movement of material in or out of the tank, whether the valves are at the tank or at remote manifolds. *Tank isolation* may also involve de-energizing and disconnecting switches and mechanical linkages, including lockout and/or tagout and sealing, to preclude the input of energy such as required for heating, mixing, aerating, etc.

Note: Fire protection systems, such as foam lines leading into the tank, may remain active during tank isolation in accordance with work being performed and facility procedures.

## 4 General Precautions for Descent Onto Floating Roofs

### 4.1 GENERAL CONDITIONS

**4.1.1** Whenever descent onto a floating roof is determined to constitute permit-required entry into a confined space, entry and work conditions shall follow the safe work practices recommended in API Standard 2015 and OSHA 29 *CFR* 1910.146 confined space and other applicable regulatory requirements.

**4.1.2** Descent onto any internal or covered open-top floating roof always constitutes entry into an OSHA permit-required confined space unless the tank is out of service and cleaned and the atmosphere is determined to be safe for entry. Each tank owner and operator shall therefore establish a Permit Space Program to control and authorize descent onto internal and covered floating roofs of in-service tanks.

**4.1.3** Descent onto an open top floating roof may or may not be considered entry into a permit-required confined space, depending on several factors. For open-top floating-roof tanks, the tank owner or operator shall determine the conditions that constitute permit-required confined space entry. When these conditions are met, the appropriate permit-required confined space entry procedures shall be established and followed for each specific descent onto open-top floating roofs.

**4.1.4** Whether or not an entry permit is required, facility procedures for descent and entry onto floating roofs and potential hazards shall be covered in a pre-job conference including appropriate supervisory, entry, and attendant personnel. Typical potential hazards that may be expected to be encountered during descent and entry onto floating roofs are outlined in Section 5 of this document.

**4.1.5** When descent onto a floating roof is determined to constitute entry into a permit-required confined space, an entry permit shall be issued by a designated entry supervisor. Permit conditions, entry and egress procedures, atmospheric testing requirements, respiratory protection, emergency procedures, and safe work practices shall, as a minimum, follow the recommendations provided in OSHA 29 *CFR* 1910.146 and other applicable regulatory requirements.

### 4.2 PERMIT SPACE PROGRAM REQUIREMENTS

**4.2.1** The Permit Space Program applicable to entry onto floating roofs of tanks shall include the following, as a minimum:

- a. Establishment of measures necessary to prevent unauthorized entry onto floating roofs.
- b. Determination of methods to identify, evaluate, and protect entrants from potential hazards associated with entry onto floating roofs.
- c. Development of criteria for acceptable entry conditions for each type of tank and tank service and each type of floating roof prior to entry; and to verify safe conditions throughout the duration of entry onto a floating roof.
- d. Definition of methods, when applicable, for isolating the tank and for purging, inerting, or ventilating the area above and below (if out of flotation) the floating roof.
- e. Development and implementation of requirements for preparation, issuance, use, and cancellation of entry permits which provide for coordination between entrants, especially when more than one employer or contractor is involved in the work.
- f. Provision for review of the Permit Space Program as tank-age, storage and conditions change.
- g. Provision for testing, communications, respiratory and personal protective, lighting, barrier, ventilation, rescue and emergency response equipment required for safe entry onto floating roofs.
- h. Assurance that knowledgeable, trained, and qualified entry supervisors, attendants, testers, and entrants are designated for each permit-required confined space entry onto a floating roof.
- i. Requirements that entry supervisors, entrants, and attendants, if any, shall be familiar with the potential hazards and emergency services applicable to each specific permit-required confined space entry.
- j. The presence of at least one attendant to be stationed at the top of the tank for the duration of permit-required confined space floating-roof entry operations.
- k. Development and implementation of rescue and emergency response procedures applicable to floating-roof entry, including summoning rescuers, retrieving entrants, providing emergency services for entrants, and preventing unauthorized persons from attempting a rescue.
- l. Provision for hazard communications awareness or training for all entrants, testers, entry supervisors, attendants, and rescue persons, covering the material contained in the tank whose floating roof is to be entered.

### 4.3 REQUIREMENTS FOR DESCENT ONTO FLOATING ROOFS

The entry supervisor shall assure that all necessary tests have been conducted and that all personnel, procedures and equipment required by the entry permit are in place before authorizing descent onto the floating roof.

## 5 Potential Hazards Associated with Entry Upon Floating Roofs

### 5.1 GENERAL ATMOSPHERIC TESTING REQUIREMENTS

**5.1.1** The oxygen content of the atmosphere above the floating roof may be above or below the minimum levels for safe entry, hydrocarbon vapors (for example, gasoline) may be present in the flammable range, and the atmosphere may contain toxic vapors (for example, benzene or hydrogen sulfide) that exceed established exposure limits for safe entry without respiratory equipment.

**5.1.2** Before initial descent upon a floating roof is authorized, the entry supervisor shall identify the potential atmospheric hazards, determine the permit entry requirements, and evaluate the test results.

**5.1.3** A tester (who could also be the entry supervisor and/or an entrant) shall be designated to conduct appropriate testing for atmospheric hazards in the following sequence: (a) oxygen, (b) flammability (combustible gases or vapors), and (c) toxic air contaminants. Initial testing of the atmosphere above the surface of internal and covered open-top floating roofs shall be conducted through the sampling and gauging hatches or other appropriate place outside the tank.

**5.1.4** As a minimum, atmospheric testing shall be conducted prior to descent at the beginning of each shift, prior to reentry after any prolonged periods of inactivity or work interruption, prior to starting hot work, and any time conditions are suspected to have changed. Testing of the atmosphere in the work area above the surface of the floating roof shall be either continuous or conducted as necessary to assure the continuation or maintenance of permitted safe working conditions. The need for continuous or intermittent monitoring and the use of approved respiratory protective equipment shall depend on the results of the testing and the potential for increased atmospheric contamination or oxygen availability during entry and work operations.

**5.1.5** Should subsequent testing indicate that exposure limits or permit conditions are not being met or are exceeded, the entry supervisor shall determine whether or not work is to be continued and, if so, under what conditions and requirements. Otherwise, continued entry shall be denied, the entry supervisor or attendant shall cancel the permit, and work shall cease until such time as the established entry requirements are met.

### 5.2 POTENTIAL OXYGEN CONTENT HAZARDS

**5.2.1** Atmospheric testing for oxygen levels shall be conducted before entry onto a floating roof in order to determine (a) whether sufficient oxygen is present in the atmosphere to conduct flammable vapor testing, (b) whether oxygen levels

are within, above, or below the limits required to allow entry without air-supplied respiratory protection (provided that no toxic atmosphere is present), and (c) if oxygen levels are too high to either enter the confined space or to determine correct upper flammable limits and lower flammable limits of any flammable vapor which may be present.

**5.2.2** The oxygen content of the atmosphere above the floating roof shall be tested to determine if it is below 19.5%, the current OSHA-established minimum level for safe entry into a confined space without using air-supplied respiratory protection.

Note: OSHA does not permit entry into confined spaces whenever the oxygen content exceeds 23.5%.

**5.2.3** The oxygen content of the atmosphere shall be tested to determine if it is below 10%, in which case there is not enough oxygen present to accurately determine flammable vapor levels.

### 5.3 POTENTIAL FLAMMABLE VAPOR HAZARDS

**5.3.1** Atmospheric vapor testing shall be conducted to determine whether or not a flammable vapor air mixture is present in the atmosphere above floating roofs prior to entry. Flammable or combustible liquids may be present on the floating roof, or in the pontoons, floats, or seal areas.

**5.3.2** The flammable vapor or gas content of the atmosphere above the floating roof may be above 10% LFL, the current OSHA-established maximum level for safe entry into a confined space. In such cases, the space above the floating roof may need to be ventilated to reduce the concentration of vapor in air or inerted to eliminate oxygen, and the atmosphere retested prior to permitting entry.

**5.3.3** A flammable atmosphere may also be present inside pontoons, floats, and primary and secondary seal areas or underneath floating roofs out of flotation. These areas must be considered as separate confined spaces and must be tested appropriately, with entry restricted if the flammable vapors inside the area exceed 10% LFL. These spaces may also need to be ventilated or inerted, and the atmosphere retested, prior to permitting entry.

### 5.4 POTENTIAL TOXIC VAPOR AND GAS HAZARDS

**5.4.1** The atmosphere above the floating roof may contain hazardous hydrocarbon vapors (such as gasoline), toxic vapors (such as hydrogen sulfide, benzene or organic lead), or inert gases (such as nitrogen) that exceed established exposure levels for safe entry without approved respiratory and personal protective equipment.

Note: See OSHA, 29 CFR 1910.134, *Standard for Respiratory Protection*, and API Standard 2015.



**5.4.2** A determination shall be made of the toxic substances known or suspected to be present in the atmosphere of the confined space. Information concerning potential exposures and proper precautions with respect to specific hazardous materials and conditions shall be obtained from (a) the employer, tank owner or operator, or from the manufacturer or supplier of the material, (b) established standards such as OSHA and publications such as ACGIH, or (c) the material safety data sheet (MSDS) for the product involved.

**5.4.3** Atmospheric testing for contaminants shall be conducted by a tester before entry onto a floating roof in order to determine whether or not toxic exposures are present in excess of established permissible exposure limits. The need for continuous or intermittent monitoring and the selection and use of respiratory protective equipment shall depend on the results of the testing and the potential for increased or continued exposure during entry. If potential exists for acute toxic exposures, such as  $H_2S$ , use of continuous monitoring equipment shall be used even if initial monitoring indicates safe levels.

**5.4.4** The employer shall document the basis for determining that all potential hazards in a permit-required confined space have been eliminated, using a certification (entry permit) available to all entrants containing the date, location, and signature of the person making the determination.

**5.4.5** Because many petroleum products have permissible exposure limits (PELs) in parts per million which are considerably less than their lower flammable limits (LFLs), the permissible exposure limit, rather than a percentage of the LFL, shall be the criteria for entry without respiratory protection.

**5.4.6** The tank owner or operator shall provide material safety data sheets covering products that have been stored in the tank, which address toxic substances and their potential effects, permissible exposure levels, and personal protection information.

## 5.5 POTENTIAL VAPOR EXPOSURES

**5.5.1** Even when the floating roof structure is in good mechanical condition, vapors may escape past the roof seals and gauge pipe well seals and, in some cases, may migrate through the automatic bleeder (pressure vacuum) vent or other openings in the floating roof. The quantity of vapors escaping during normal tank operation is usually negligible provided that the seals are in good condition and neither the shell nor the roof is distorted.

**5.5.2** Escaping vapors may also accumulate in pontoons of the floating roof as a result of leakage. Pontoons should be considered as confined spaces and atmospheric testing and appropriate permit system and entry procedures should be followed whenever workers are required to enter a pontoon.

**5.5.3** Some of the factors which affect the quantity of vapors that may escape include, but are not limited to, the following:

- a. *Condition of seals*—An increased quantity of vapors will escape past seals that are in poor condition.
- b. *Petroleum products entering the tank*—A volatile stock or high-temperature product entering the tank may lead to the creation of an increased quantity of vapors, especially at high pumping rates.
- c. *Mixing or agitation*—When the tank contents are mixed or agitated, vapors under the roof may escape past the seal or through the automatic bleeder vent. A substantial vapor release can cause entrained liquid to blow past the seal and accumulate on top of the floating roof.
- d. *Tank operations*—When pumping out of the tank, especially at high pumping rates, the wetted walls of the tank may lead to the creation of an increased quantity of vapors in the space above the floating roof.
- e. *Roof out of flotation*—A roof is inherently more vapor-tight when it is in flotation. Support-leg wells and tank gauge float wells do not function as vapor barriers when the liquid level has dropped below the bottom of the wells. When a floating roof is on its legs, the area between the floating roof and the liquid level will be occupied by vapors or a mixture of vapors and air.
- f. *Returning a tank to service*—The greatest vapor concentration above the floating roof may be expected when the roof has been out of flotation and is then being refloated (the tank is being refilled). These vapors may persist for extended periods depending on conditions.
- g. *Abnormal roof condition*—Vapors will be present if the floating roof sinks beneath the surface of the product or if it is hung up inside the tank in a tilted position.

## 5.6 POTENTIAL FIRE HAZARDS

**5.6.1** Some of the potential fire hazards associated with descent upon floating roofs include, but are not limited to, the following:

- a. A flammable vapor air mixture may exist in the atmosphere above the floating roof (e.g., a roof seal can leak).
- b. A flammable or combustible liquid may be present on the floating roof (e.g., due to overflow or pontoon leakage).
- c. A flammable or combustible liquid or vapor may be present in the pontoon or in the seal area (e.g., due to a pontoon leak or a rupture in the seal).
- d. When the floating roof is out of flotation, and the liquid level is below the roof support, a flammable vapor air mixture may exist in the atmosphere below the roof (e.g., roof seal does not seal properly and air entered the interstitial space).
- e. When filling a tank whose roof has been out of flotation and the liquid level has been below the roof level, vapors may be forced through the roof seal and into the atmosphere above the floating roof.

f. Absorbent buoyant materials used in the construction of some floating roofs may retain flammable or combustible liquids.

Note: Some plastics may be susceptible to fire damage or sustain combustion even without absorption.

## 5.7 POTENTIAL PHYSICAL HAZARDS

**5.7.1** Entry onto floating roofs presents potential physical hazards including, but not limited to, restricted entry and exit, limited visibility in internal and covered open-top floating-roof tanks, tripping and falling. Employers shall assure that safe work practices address potential physical hazards associated with entry onto floating roofs in their facilities.

**5.7.2** Examples of falling and tripping hazards include, but are not limited to, the following:

- a. Falling from a ladder or stairway.
- b. Falling from a tank roof or walkway onto the floating roof.
- c. Slipping, tripping, or falling upon the floating roof.
- d. Corrosion may occur to the underside of floating roofs in contact with products such as high sulfur crude oil; therefore, falling through a corroded open-top or covered open-top floating roof into product and sinking is a potential hazard.

Note: Humans will not float in gasoline and other light products.

e. It is also possible to fall through the floating roof of an internal floating-roof tank.

**5.7.3** The floating roofs of open-top or covered open-top floating-roof tanks are usually constructed of steel with pontoons for flotation and, when in good condition, will support the weight of workers and equipment. Floating roofs shall be visually inspected from above for structural stability prior to descent. Because some mechanical deficiencies and corrosion may not be noticeable from the top platform, if there is any doubt about the integrity of a floating roof, metal-thickness readings or other appropriate structural testing or measurements should be obtained using proper safety precautions.

**5.7.4** Internal floating roofs may be constructed of lighter materials (such as foam, plastic, fiberglass or aluminum) and mechanical damage or defects may not be easy to recognize. Some internal floating roofs have pontoons for greater buoyancy and others do not. Entry upon internal floating roofs which do not have pontoons for increased buoyancy should be considered extremely hazardous and conducted under specific safe work procedures and practices to protect entrants from engulfment by product should the roof sink or tilt.

**5.7.5** Some internal floating roofs have walkways which are constructed of a more substantial material that will distribute weight. If such walkways are not included, the temporary placement of metal planks or plywood should be considered to improve weight distribution. When entering onto internal floating roofs, the tank owner or operator should obtain and follow the maximum allowable load concentrations provided by the roof manufacturer.

**5.7.6** If weak areas are found during inspection or are known to exist in the floating roof, access to these areas shall be prohibited until suitable reinforcement has been provided.

**5.7.7** Medium and large diameter open-top and covered open-top floating-roof tanks are normally provided with movable internal stairways and ladders which are usually easy to negotiate; but at very high and very low roof positions, the steps are often at awkward angles and special precautions may be needed when descending and climbing.

**5.7.8** Some small-diameter, open-top, and covered open-top floating-roof tanks and most internal floating-roof tanks have stationary vertical ladders that extend from the top platform down through a well in the floating roof to the tank floor.

a. It is advisable to schedule entry at a time when the floating roof is in its highest practical position, but preferably not less than 8 feet (2.4 meters) below the lowest point of the fixed roof, thus minimizing the entrant's travel distance while providing adequate height to stand on an internal floating roof without interference from the fixed roof above.

b. When the floating roof is in its lowest position, climbing down the ladder to the floating roof constitutes a considerable travel distance and a ladder-climbing safety device should be considered.

**5.7.9** Adequate lighting, suitable for the area's hazard classification, shall be provided for work to be performed on the floating roof. Lighting equipment shall be in good condition, adequately protected from mechanical damage and kept clear of liquids. Where needed, lighting equipment shall meet the requirements of NFPA 70 for Class I, Division 1 locations. Types of lighting which may be considered include, but are not limited to: (a) general illumination of the entire work area which enables the attendant to maintain surveillance of operations on the floating roof, and (b) task lighting required at the work location on the floating roof.

**5.7.10** The outside roofs and covers, wind girders, ladders, stairways, walkways and rails, and other roof supports and appurtenances shall be inspected to assure they can hold and support the weight of any equipment or material which is to be placed on top of them, or attached to them, for lowering onto the floating roof, prior to such use.



## 6 Preparation for Entry Upon Floating Roofs: Ventilation, Testing, and Rescue

### 6.1 VENTILATION REQUIREMENTS

#### 6.1.1 Natural Ventilation

Factors that influence the natural dissipation of vapors above floating roofs include, but are not limited to the following:

a. *Tank size*—Floating-roof tanks with a large diameter-to-height ratio allow more rapid dilution and dissipation of vapors.

Note: See API Standard 650 for methods of determining the minimum venting requirements.

b. *Vapor characteristics*—Lighter vapors diffuse in air and escape more rapidly, whereas heavier vapors persist for a longer period of time.

c. *Roof elevation*—Vapors dissipate and escape more rapidly when the floating roof is at a higher position.

d. *Atmospheric conditions*—Ambient temperature affects the dissipation of vapors over a liquid pool of product on the roof. The time of day, weather conditions and the amount of area exposed affect the rate of vaporization. Air movement dilutes vapors, disperses them and speeds up the vaporization process. The greater the air movement, the faster the dissipation.

Note: Extremely high winds blowing across the roof of an open-top floating-roof tank in the high roof position can create negative pressure in the vapor space, causing the release of more vapors and, in extreme cases, even liquid product.

e. *Refloatation*—When open-top floating roofs are refloated, vapor concentrations usually reach levels that allow safe entry in approximately 1 to 4 hours depending on product, roof conditions, roof height, and wind velocity. With internal floating roofs, the period is much longer, and can vary from 12 to more than 48 hours after refloatation.

**6.1.2** Mechanical ventilation is seldom necessary on an open-top floating roof, especially if the floating roof is at a high position. Mechanical ventilation may be necessary in order to reduce flammable and toxic vapor levels or increase oxygen levels inside internal and covered open-top floating-roof tanks, particularly if leakage past seals or any other appurtenances could produce a change in the atmosphere while work is in progress.

**6.1.3** Mechanical forced-air ventilation arrangements will vary according to the type, size and configuration of the tank. Air- or steam-driven eductors or blowers are recommended in order to reduce ignition hazards. If electric motor-driven blowers are used, they shall be suitable for the area's electrical hazard classification. All air movers shall be properly bonded to the tank shell or roof to eliminate the possibility of any electrostatic accumulation.

Note: See API Standard 2015 for specific details on tank ventilation.

**6.1.4** Continuous mechanical forced-air ventilation, if needed, shall comply with the following OSHA confined space entry requirements:

a. Entry shall not be permitted until forced-air ventilation has eliminated the hazardous atmosphere.

b. The forced-air ventilation shall be directed so as to ventilate the immediate work area on the floating roof and shall continue until workers have left the space.

c. The air supply shall be from a clean source and may not increase the hazards in the space.

d. The atmosphere within the work area shall be periodically tested as necessary to ensure that the continuous mechanical forced-air ventilation is preventing the accumulation of any hazardous atmosphere.

### 6.2 ATMOSPHERIC TESTING REQUIREMENTS

#### 6.2.1 General

**6.2.1.1** A tester shall be designated to conduct atmospheric testing using approved, properly calibrated and adjusted instruments. This testing shall include measuring for oxygen, flammable vapors, and potentially hazardous toxic materials. Ventilation equipment should be shut down for 15 minutes (based on industry experience) to allow the tank atmosphere to reach equilibrium conditions before testing the interior.

**6.2.1.2** The tester should visually inspect the internal ladder (or stairway) and the floating roof to identify obvious problems such as mechanical damage or liquid upon the roof. The floating roof should also be visually inspected for levelness as a roof which is not level may indicate pontoon leakage or other damage leading to instability.

**6.2.1.3** Results of testing the atmosphere above the floating roof must meet the following criteria:

a. The oxygen content of the air is at least 19.5% and no greater than 23.5% for entry onto the floating roof without air-supplied respiratory protection (provided that there are no hydrocarbon vapors or toxic materials present in the atmosphere above acceptable limits).

b. The oxygen content of the atmosphere is at least 10% in order to accurately determine flammable hydrocarbon vapor levels.

c. Hydrocarbon vapors levels in the atmosphere are below 10% of the LFL in order to allow entry onto the floating roof with approved air-supplied or air-purifying respiratory protection, depending on the situation.

Note: Flammable vapors must be below 10% LFL to allow entry into a confined space using approved air-supplied respiratory protection. Should vapors rise above 10% LFL, work must stop immediately and entrants shall leave the floating roof. Work may not resume until further testing indicates that the vapor level has dropped below 10% LFL.

d. Toxic materials and other hazardous substances are below their exposure limit values if entry is to be made without respi-

ratory protection, or if respiratory protection is to be used, do not exceed the level of protection provided by the respirator.

e. Hydrocarbon vapors do not exceed the exposure limits for the products or any of their components, or if respiratory protection is to be used, do not exceed the limits for the level of protection provided by the respirator.

Note: Most petroleum products have an exposure limit in parts per million far lower than the LFL entry criteria. This exposure limit, rather than a percentage of the LFL, will therefore be the criterion for entry without respiratory protection.

**6.2.1.4** Tests shall be repeated as necessary to verify safe and acceptable conditions for continued entry. As a minimum, tests should be repeated at the start of each successive shift, after any prolonged periods of inactivity or work interruption and any time conditions are suspected to have changed. The frequency of testing should be based on the individual situation. In some situations, continuous monitoring may be required when hydrocarbon vapor or toxic substance concentrations could change, such as when a tank is in service during entry.

**6.2.1.5** If test results show that toxic exposure or hydrocarbon vapor limits are exceeded, the entry supervisor shall decide whether to continue mechanical ventilation or to permit entry and work using appropriate respiratory protection. Otherwise, entry should be denied until safe limits are met. When a decision is made to permit entry with appropriate respiratory equipment, compliance with applicable regulations is required (see OSHA 29 *CFR* 1910.146).

## **6.2.2 Closed Open-Top and Internal Floating-Roof Tanks**

**6.2.2.1** Before initial descent onto the floating roof is authorized, the assigned tester shall conduct atmospheric tests from outside the tank, i.e., initial testing of the atmosphere on top of the floating roof shall be conducted from the top of the tank, prior to descent. Test samples should be taken at several elevations. In order to preclude the possibility of a static electricity discharge, the tester, when approaching the top and before opening any gauge hatch or other openings, shall touch the steel handrail or tank shell with a bare hand.

**6.2.2.2** After atmospheric tests have been conducted from outside the tank, the tester shall descend cautiously, testing during the descent. During the descent for the purpose of gas testing, the tester shall wear an approved air-supplied respirator if the tank contains refined product. If the tank contains materials such as leaded gasoline or products with high sulfur contents, which may create potentially harmful exposures, the tester shall wear an approved air-supplied respirator with an escape pack or self-contained breathing apparatus.

## **6.2.3 Open-Top Floating-Roof Tanks**

**6.2.3.1** Before initial descent onto the floating roof of open-top tanks (and open-top, floating-roof tanks which are covered with semi-fixed geodesic or similar domes) is authorized, the tester shall conduct atmospheric tests from outside the tank. This can be done by lowering test instruments or sample-collecting devices from the top of the tank. Test samples should be taken at several elevations within the space between the floating roof and the top of the tank.

**6.2.3.2** After atmospheric tests have been conducted from outside the tank, the tester shall descend cautiously, testing during the descent. If tests indicate any values outside acceptable limits (see 6.2.1.3 above), the tester shall retreat from the tank immediately and the situation shall be reevaluated to determine the appropriate course of action. Regardless, if the tank contains materials such as leaded gasoline or products with high sulfur contents which may create potentially harmful exposures, the tester shall wear an approved air-supplied respirator with an escape pack or self-contained breathing apparatus. Descents without respiratory equipment are permissible, provided that atmospheric and operating conditions meet the requirements established by the employer or a designated entry supervisor.

## **6.3 EMERGENCY RESCUE PLANNING**

**6.3.1** Difficult rescue situations can develop if entrants become ill, are injured, or are otherwise incapacitated while on the floating roofs of tanks. The appropriate rescue provisions to be used will depend upon the type, service, operation of the tanks, and work being performed on the floating roofs.

**6.3.2** Emergency rescue plans are required for OSHA permit-required confined spaces. Facilities should also consider emergency rescue plans covering entry onto non-permit-required floating roofs.

**6.3.3** Emergency rescue plans shall be in writing and should address, but not be limited to, the following:

- a. Attendant and rescue personnel duties.
- b. Procedures for summoning rescue and emergency services.
- c. Methods for rescuing entrants.
- d. Provisions for necessary emergency medical services for rescued personnel.
- e. Preventing unauthorized personnel from attempting a rescue.

**6.3.4** Emergency rescue plans should be covered in the pre-job conference which includes the entry supervisor, entrants, attendants, and on-site rescuers (if used). Local fire departments and/or rescue squads shall be notified (if used) to assure availability if needed (see 6.3.7). The plans should include provisions needed to effect a rescue, including emergency phone numbers if required.



**6.3.5** An attendant shall be stationed at the top of the ladder or near the roof opening to maintain visual or aural contact with the entrants on the floating roof. The attendant shall be trained to recognize hazards and changing conditions and shall be equipped with a horn, a two-way radio approved for the area's electrical hazard classification, or another means of summoning assistance.

**6.3.6** If the work being performed has the potential for exposure to liquid or vapors, or if the entrants on the floating roof are using respiratory protective equipment, attendants and rescuers shall be provided with equivalent respiratory protective equipment or self-contained breathing apparatus.

**6.3.7** The attendant shall immediately advise the entrants if an emergency occurs elsewhere in or near the facility which requires them to exit from the floating-roof tank.

**6.3.8** If a facility rescue team is to be used, the emergency rescue plan should identify the personnel who are trained and qualified to perform the rescue, the rescue equipment that is readily available and the appropriate procedure to be used to evacuate the entrant(s) from the floating roof. If an outside entity, such as a local fire department or mutual aid group, is to provide emergency rescue service, the method of determining the areas of responsibility should be detailed in the plan.

## **7 Procedures for Descent Onto Open-Top Floating Roofs**

### **7.1 GENERAL**

**7.1.1** Descent onto open-top floating roofs may or may not be considered as permit-required confined space entry. Facilities shall evaluate specific tanks, their contents, floating-roof levels, potential hazards, and the work to be performed and determine whether or not the conditions constitute either non-permit-required confined space entry or permit-required confined space entry. Descent upon permit-required open-top floating roofs shall require issuance of a permit by the designated entry supervisor. Descent upon non-permit-required open-top floating roofs should be authorized by a designated knowledgeable and competent entry supervisor or tester.

### **7.2 PREPARATIONS PRIOR TO DESCENT ONTO OPEN-TOP FLOATING ROOFS**

**7.2.1** Each facility shall develop, have, and maintain written programs or written procedures for descent onto permit-required and non-permit-required open-top floating roofs which take into consideration the tanks, their construction, condition, potential hazards, service, and operations. The designated entry supervisor is to ensure that all the required conditions specific to the proposed work have been met prior to issuing an entry permit.

**7.2.2** A pre-job meeting shall be conducted with facility and contractor personnel which includes the designated entry supervisor, tester, entrant(s), attendant(s), and designated rescuers (if needed) to review the proposed work, potential hazards, entry conditions, and emergency plans.

**7.2.3** The open-top floating roof should be in flotation (not sitting on its legs) and the bleeder valve closed prior to descent. Prior to allowing entry upon the open-top floating roof, a minimum of 1 to 4 hours should be allowed for dissipation of vapors after an open-top floating-roof tank has been refloated and product delivery has stopped (see 4.1).

**7.2.4** Entrants shall not be allowed to descend onto an open-top floating roof which is out of flotation (sitting on its legs) until atmospheric testing has been conducted both above and below the open-top floating roof and conditions allow the issuance of an entry permit.

**7.2.5** Conditions to be considered when preparing for descent onto an open-top floating roof include, but are not limited to, the following:

a. *Atmospheric conditions*—The oxygen content of the atmosphere shall be between 19.5% and 23.5% for entry without air-supplied respiratory protection (provided that there are no hydrocarbon vapors or toxic materials present in the atmosphere above acceptable limits); hydrocarbon vapors are below 10% of the LFL; and hydrocarbons and hazardous or toxic substances such as hydrogen sulfide do not exceed their permissible exposure limits (or if respiratory protection is to be used, do not exceed the level of protection provided by the respirator) (see 6.2.3).

If work is to be performed on or near seals or other openings, additional tests must be performed to ensure that the atmosphere in the immediate work area is not toxic and that hydrocarbon vapor levels remain below their PELs, or 10% LFL, whichever is applicable.

b. *Tank service conditions*—In addition to hydrocarbon flammability factors, tanks must be evaluated with respect to potentially toxic exposures. For example, tanks containing petroleum products with high sulfur contents present the added hazard of acute hydrogen sulfide toxicity and tanks which have been in leaded gasoline service may expose entrants to toxic lead hazards.

c. *Operating conditions*—Whenever possible, the open-top floating roof should be in the highest position prior to entry. For descent onto a permit-required open-top floating roof, either (1) the tank valves should be closed, locked and tagged, (2) the lines should be disconnected and blinded or blanked, or (3) the valves should be closed and double blocked and bled.

Note: For tasks of short duration such as gauging and sampling or when performing minor maintenance activities on open-top floating roofs when product is not being discharged or received, it may not be necessary to close tank valves or blind tank lines.

Product shall never be put into a tank while entrants are on a permit-required open-top floating roof.

d. *Physical conditions*—Prior to descent, the open-top floating roof shall be checked for potential physical hazards and stability (see 5.7).

e. *Power-driven equipment conditions*—When required by the permit, all electrical, steam, and other power-operated equipment such as tank mixers, heaters, steam coils, and remote control tank valves shall be shut off at their motor controllers and locked and/or tagged in accordance with the facility's lockout/tagout and tank isolation procedures. Following lockout/tagout, push-button stations should be operated to ensure that power has actually been disconnected.

f. *Weather conditions*—Electrical storms in the vicinity can present special hazards that must be considered at the time of occurrence. Descent onto open-top floating roofs of tanks should not be conducted during electrical storms, tornadoes or high wind conditions.

Note: Work on open-top floating roofs shall be suspended, the floating roof shall be returned to a normal (safe) condition, and entrants and attendants shall vacate the roof during lightning storms.

g. *Lighting conditions*—Safe, appropriate low-voltage lighting, approved for the area's classification, shall be provided, if required (see 5.7.9).

### 7.3 INITIAL DESCENT ONTO OPEN-TOP FLOATING ROOFS

**7.3.1** Atmospheric testing shall be conducted prior to the issuance of an entry permit or other authorized entry upon an open-top floating roof (see 6.2). An attendant shall be stationed at the platform or access ladder on the roof of the tank, to observe and maintain visual and/or aural contact with the tester during the initial descent. During the initial descent, the tester shall also assess the mechanical condition of the open-top floating roof, access ladders, and stairways.

**7.3.2** Following the initial descent and completion of atmospheric testing and inspection by the tester, the entry supervisor shall assure that all the required conditions specific to the proposed work have been met prior to issuing an entry permit or authorizing entry onto a non-permit-required open-top floating roof (see 6.2.6 and 6.2.7).

**7.3.3** The entry supervisor shall notify the facility manager, supervisor, tank owner, or operator prior to descent by entrant(s) onto the open-top floating roof. A system shall be established to assure that all personnel on the job, both inside and outside the tank, are accounted for at all times.

**7.3.4** Whenever the open-top floating roof is more than 4 feet (1.2 meters) below the top of the tank, an attendant shall be stationed at the access ladder on the roof of the tank to observe the tester and entrant(s) during their initial descent onto the open-top floating roof. If the operation is considered to be an entry into a permit-required confined space, an atten-

dant shall remain on duty throughout the period that entrant(s) are on the floating roof.

### 7.4 WORKING ON OPEN-TOP FLOATING ROOFS OF TANKS IN SERVICE

**7.4.1** Following the initial descent and prior to all subsequent descents, the entry supervisor shall check that the original entry conditions have been met (see 6.2 and 7.2).

**7.4.2** Should operating, physical, or atmospheric conditions change so that the area is no longer safe for work, entrants shall leave the floating roof immediately and shall not return until retesting is completed and the entry supervisor has determined that safe entry conditions have been met. (see 6.2 and 7.2).

**7.4.3** Atmospheric testing shall be conducted continuously or at regular intervals during work on the open-top floating roof (see 6.2). If work is to be performed on or near seals, vents, or other openings, additional testing must be conducted to assure that the atmosphere in the immediate work area meets established safe work conditions (see 7.2 and 7.5).

**7.4.4** Continuous forced-air mechanical ventilation may be necessary to maintain a safe atmosphere in the space above the internal or covered open-top floating roof. Entry shall not be permitted until the forced-air ventilation has reduced the hazards as required by the entry or hot work permit. When required, forced-air ventilation shall be directed so as to ventilate the area where entrants are working and ventilation shall continue until the tank is vacated (see 6.1).

**7.4.5** During maintenance or repair work on an open-top floating roof, or when entrants will be on the roof for more than a brief visit, entrant(s) should have available at least two 30 lb. BC-type portable fire extinguishers, ready for use.

**7.4.6** Any entry into the pontoons or underneath the secondary seals of an open-top floating roof shall be considered as permit-required confined space entry. Each individual space shall be checked by the tester to determine the atmospheric conditions prior to the issuance of an entry permit by the entry supervisor.

**7.4.7** At the end of each work period or upon vacating the open-top floating roof for any extended period of time, the floating roof shall be returned to a safe condition, as near to normal as possible, with all seals and bonding shunts or straps in place and all materials, tools, and equipment removed.

**7.4.8** Although tanks should normally be in a static condition, operating conditions or emergencies may require that product be moved into or out of the tank while cold work, such as inspection, maintenance, or secondary seal repair is in progress (see 7.5.2). Product withdrawal/receipt shall require the approval of the tank owner or operator and the entry supervisor. Use of a cold work permit or other written proce-



dures is recommended to address safety requirements. *The rate of product withdrawal should be controlled so that the level of the open-top floating roof does not drop more than 5 inches (0.1 meter) per hour.* Atmospheric monitoring shall be conducted during product withdrawal to assure that flammable vapor and toxic exposures do not exceed the levels established by the permit.

## 7.5 PERMISSIBLE WORK ON OPEN-TOP FLOATING ROOFS

**7.5.1** By following appropriate established safe work and entry procedures and obtaining written approval, certain types of work can be performed upon open-top floating roofs of tanks in service. Whenever possible, work should be scheduled for a period when the floating roof is in a high position.

**7.5.2** Examples of cold work which may be performed upon open-top floating roofs of tanks which are in petroleum service include, but are not limited to, the following:

- a. Adjustment of open-top floating roof support legs from high to low position after the tank is placed into service and from low to high position before the tank is taken out of service.
- b. Adjustment of the vent or bleeder valve relief in the open-top floating roof.

Note: This vent will normally be closed when the roof is in flotation.

- c. Gauging, sampling and temperature measurement of the product in the tank.
- d. Adjustment and repair of the level gauge.
- e. Inspection of the open-top floating roof, pontoons, seals and fire protection system.
- f. Opening, closing and mechanical repairs and maintenance of open-top floating-roof water drains.
- g. Adjustment and repair of the anti-rotation devices.
- h. Painting, cleaning, and cold work (non-spark-producing) surface preparation prior to painting, using hand-held or air powered tools only.

Note: The open-top floating roof should be in a high position. Painting and cleaning may require ventilation because of solvent vapors produced by paint or cleaners.

- i. Installation or repair of secondary seals and repair or replacement of bonding straps and shunts on open-top floating roofs under carefully controlled conditions to preclude ignition sources.

Note: A means of positive bonding between the open-top floating roof and the tank shell must be maintained at all times.

Only self-tapping screws and bolts shall be used to affix materials to the open-top floating roof. Cutting and drilling operations shall be continuously flushed using water or approved coolant to prevent heat buildup and sparking.

- j. Removal of blasting grit, dirt, dust, liquid, ice or snow from the open-top floating roof using hand-held tools or air powered equipment without creating sparks or heat.

- k. Inspection, measurement of seal gap, installation, repair or replacement of secondary seals, with the open-top floating roof in a high position.

**7.5.3** Examples of hot work which may be performed upon open-top floating roofs of tanks which are in petroleum service include, but are not limited to the following:

Note: Hot work requires issuance of a hot work permit in addition to any required entry permit.

- a. Abrasive blasting and grinding using air powered equipment with the open-top floating roof in a high position.

Note: Locate air compressors upwind, outside of, or on top of, the dike and a minimum of 50 feet away from the tank or other sources of flammable vapors.

**CAUTION:** Abrasive blasting should be done only under carefully controlled and permitted conditions (see API Publication 2027).

- b. Minor repairs and replacement of one section of primary seal at a time, under carefully controlled and permitted conditions, in order to preclude vapor releases, ignition sources (including lightning), etc. Tanks shall be in a static condition and product movement to or from the tank shall be prohibited during repair of primary seals.

Note: A layer of fire fighting foam may be placed on top of the exposed liquid in the annular area between the open-top floating roof and the tank shell in order to control release of flammable vapors while seals are removed.

**7.5.4** Entrant(s) engaged in cleaning liquid product, sludge, rust, and scales from open-top floating roofs, including pontoons, seals areas, vents, and appurtenances on tanks which have previously contained leaded gasoline or products containing toxic materials such as hydrogen sulfide, shall wear appropriate approved personal protective clothing and air-supplied respiratory apparatus with escape packs or self-contained breathing apparatus (see API Standard 2015).

## 8 Procedures for Descent Onto Internal and Covered Open-Top Floating Roofs

### 8.1 GENERAL

**8.1.1** Descent onto internal floating roofs or covered open-top floating roofs constitutes permit-required confined space entry and all associated safety requirements must be met. Each internal or covered open-top floating roof tank owner or operator shall develop and implement a permit system for entry and working within permit-required confined spaces.

Note: Access onto open-top floating roofs of tanks that utilize metallic geodesic domes or other types of caps or covers installed to minimize the accumulation of rain water or snow on the floating roof shall be considered as access into permit-required confined spaces and treated the same as access onto internal floating roofs.

**8.1.2** If a tank with an internal or covered open-top floating roof is in flammable, combustible, or toxic liquid service, descent onto the floating roof should be considered only when the work to be performed is essential to operations. This work should be limited to cold work.

## **8.2 PREPARATIONS PRIOR TO DESCENT ONTO INTERNAL AND COVERED OPEN-TOP FLOATING ROOFS**

**8.2.1** Each facility shall develop or have written procedures for descents onto internal and covered open-top floating roofs which take into consideration the tanks, their construction, condition, service, potential hazards, and operations. Descent onto internal and covered open-top floating roofs can be accomplished only upon issuance of a permit by the designated entry supervisor.

**8.2.2** The designated entry supervisor is responsible to ensure that all the required conditions specific to the proposed work have been met prior to issuing a permit for entry onto an internal or covered open-top floating roof. The entry supervisor shall give consideration to the potential atmospheric hazards in the space between the internal and covered open-top floating roof and the roof or cover on top of the tank, including oxygen deficiency, hydrocarbon vapors, and toxic chemical exposures in excess of permissible limits (see OSHA 29 CFR 1910.146).

**8.2.3** A pre-job meeting shall be conducted with facility and contractor personnel including the designated entry supervisor, tester, entrant(s), attendant(s), and designated rescuers to review the proposed work, potential hazards, entry conditions, and emergency plans.

**8.2.4** The internal or covered open-top floating roof should be in flotation (not sitting on its legs) and the bleeder valve closed prior to descent. A minimum of 12 to 48 hours (depending upon tank size, roof elevation, operations and service) before permitting entry upon the roof should be allowed for dissipation of vapors after an internal or covered open-top floating roof tank has been refloated and product delivery has stopped. Mechanical ventilation may be necessary to accelerate ventilation of the space above the internal or covered open-top floating roof in order to meet permit requirements (see 6.1).

**8.2.5** Entrants shall not be allowed to descend onto an internal or covered open-top floating roof which is out of flotation (sitting on its legs) until atmospheric testing has been conducted both above and below the floating roof and conditions allow the issuance of an entry permit.

**8.2.6** Entry supervisors shall evaluate the potential hazard of falling through or upsetting (tilting) an internal or covered open-top floating roof constructed of aluminum, light metal, foam, or plastic prior to issuing an entry permit. Each tank

owner or operator shall establish safe work procedures which are a condition of entry, to assure that the roof will adequately support personnel and equipment (see 5.7).

**8.2.7** Conditions to be considered when preparing for descent onto internal or covered open-top floating roofs include, but are not limited to, the following:

a. *Atmospheric conditions*—The oxygen content of the atmosphere shall be between 19.5% and 23.5% for entry without air supplied respiratory protection (provided that there are no hydrocarbon vapors or toxic materials present in the atmosphere above acceptable limits); hydrocarbon vapors are below 10% of the LFL; and hydrocarbons and hazardous or toxic substances such as hydrogen sulfide do not exceed their permissible exposure limits (or if respiratory protection is to be used, do not exceed the level of protection provided by the respirator) (see 6.2.3).

If work is to be performed on or near seals or other openings, additional tests must be performed to ensure that the atmosphere in the immediate work area is not toxic and that hydrocarbon vapor levels remain below their PELs or 10% LFL, whichever is applicable.

b. *Tank service conditions*—In addition to hydrocarbon flammability factors, tanks must be evaluated with respect to potentially toxic exposures. For example, tanks containing petroleum products with high sulfur contents present the added hazard of acute hydrogen sulfide toxicity; and tanks which have been in leaded gasoline service may expose entrants to toxic lead hazards.

c. *Operating conditions*—To reduce the descent distance while maintaining headroom for entrants to stand upright, prior to entry the internal roof should be raised whenever possible to a practicable height, but preferably not more than 8 feet (2.4 meters) below the fixed roof. The tank valves shall be closed, locked and tagged; or the lines shall be disconnected and blinded or blanked; or the valves shall be closed and double blocked and bled.

Note: For tasks of short duration such as gauging or sampling or when performing minor maintenance activities on open-top floating roofs when product is not being discharged or received, it may not be necessary to close tank valves or blind tank lines.

d. *Power-driven equipment conditions*—All electrical, steam, and other power-operated equipment such as tank mixers, heaters, steam coils, and remote control tank valves shall be shut off at their motor controllers and locked and/or tagged in accordance with the facility's lockout/tagout and tank isolation procedures. Following lockout/tagout, push-button stations should be operated to ensure that power has actually been disconnected.

e. *Physical conditions*—Prior to descent, the internal and covered open-top floating roofs shall be checked for potential physical hazards and stability. The potential for falling through or tilting an aluminum, expanded foam, or plastic floating roof shall be evaluated by a qualified person and the



roof manufacturer's recommendations shall be followed (see 5.7).

f. *Weather conditions*—Electrical storms in the vicinity can present special hazards that must be considered at the time of occurrence. Descent onto internal and covered open-top floating roofs of tanks should not be conducted during electrical storms, tornadoes, or high wind conditions.

Note: Work on internal and covered open-top floating roofs should be suspended, the floating roof shall be returned to a normal (safe) condition and entrants and attendants shall vacate the roof during lightning storms.

g. *Lighting conditions*—Safe, appropriate low-voltage lighting, approved for the area's classification, shall be provided if required (see 5.7.8).

### 8.3 INITIAL DESCENT ONTO INTERNAL AND COVERED OPEN-TOP FLOATING ROOFS

**8.3.1** Atmospheric testing shall be conducted prior to the issuance of an entry permit or other authorized entry upon an internal or covered open-top floating roof (see 6.2). An attendant shall be stationed at the platform or access ladder on the roof of the tank to observe and maintain visual and/or aural contact with the tester during the initial descent onto the internal or covered open-top floating roof. During the initial descent, the tester shall assess the mechanical condition of the internal and covered open-top floating roof and the access ladder.

**8.3.2** Following the initial descent and completion of atmospheric testing and inspection by the tester, the entry supervisor shall assure that all the required conditions specific to the proposed work have been met prior to issuing an entry permit (see 6.2.6 and 6.2.7).

**8.3.3** The facility manager, supervisor, tank owner or operator shall be notified by the entry supervisor or the entry supervisor's designee prior to descent by entrant(s) onto the internal or covered open-top floating roof. A system shall be established to assure that all personnel on the job, both inside and outside the tank, are accounted for at all times.

**8.3.4** Whenever the tester or entrant enters an internal or covered open-top floating-roof tank, an attendant shall be stationed at the access ladder on the roof of the tank to observe the tester and entrant(s) during their initial descent and all subsequent activity conducted inside the tank. An attendant shall remain on duty throughout the period that the tester or entrant(s) is inside the tank.

### 8.4 WORKING ON INTERNAL AND COVERED OPEN-TOP FLOATING ROOFS OF TANKS IN SERVICE

**8.4.1** Following the initial descent and prior to all subsequent descents, the entry supervisor shall check that the original entry conditions have been met (see 6.2 and 7.2).

**8.4.2** Should operating physical or atmospheric conditions change so that the area is no longer safe for work, entrants shall leave the internal or covered open-top floating roof immediately and shall not return until retesting is completed and the entry supervisor has determined that safe entry conditions have been met (see 6.2 and 7.2).

**8.4.3** Atmospheric testing shall be conducted continuously or at regular intervals during work on the open-top floating roof (see 6.2). If work is to be performed on or near seals, vents, or other openings, additional testing must be conducted to assure that the atmosphere in the immediate work area meets established safe work conditions (see 7.2 and 7.5).

**8.4.4** Continuous forced-air mechanical ventilation may be necessary to maintain a safe atmosphere in the space above the internal or covered open-top floating roof. Entry shall not be permitted until the forced-air ventilation has reduced the hazards as required by the entry or hot work permit. When required, forced-air ventilation shall be directed so as to ventilate the area where entrants are working and ventilation shall continue until the tank is vacated (see 6.1).

**8.4.5** During work on an internal or covered open-top floating roof, entrant(s) shall have available at least two 30 lb. BC-type portable fire extinguishers, ready for use.

**8.4.6** Any entry into the pontoons or underneath the seals of an internal or covered open-top floating roof shall be considered as separate permit-required confined space entries. Each individual space shall be checked by the tester to determine the atmospheric conditions prior to the issuance of an entry permit by the entry supervisor.

**8.4.7** At the end of each work period or upon vacating the open-top floating roof for any extended period of time, the floating roof shall be returned to a safe condition, as near to normal as possible, with all seals and bonding shunts or straps in place and all materials, tools, and equipment removed.

**8.4.8** Product shall never be put into a tank while entrants are on an internal or covered open-top floating roof. Whenever possible, work should be scheduled for a time when the roof will be in a high position. Tanks shall be in a static condition and neither product delivery nor withdrawal shall normally be allowed while entrants are upon the internal or covered open-top floating roof (see 8.5.4 and 8.9 for exception). Air-supplied respiratory protection and mechanical ventilation shall be provided, if needed, to minimize exposure to atmospheric combustible vapors and toxic substances (see 6.1 and 6.2).

### 8.5 PERMISSIBLE WORK ON INTERNAL AND COVERED OPEN-TOP FLOATING ROOFS

**8.5.1** Descent onto an internal or covered open-top floating roof while the tank is in petroleum service should be consid-

ered only when the work to be performed is essential to operations. By establishing safe work practices and following appropriate entry procedures, certain types of cold work can be performed upon internal and covered open-top floating roofs of tanks in service.

**8.5.2** Examples of cold work which may be performed on internal or covered open-top floating roofs of tanks which are in petroleum service include, but are not limited to, the following:

- a. Adjustment of support legs from high to low position after the tank has been placed into service and from low to high position before the tank is to be taken out of service.
- b. Adjustment of the vent or bleeder valve relief in the floating roof. This vent will normally be closed when the roof is in flotation.
- c. Gauging, sampling, and temperature measurement of the product in the tank.
- d. Adjustment and repair of the level gauge.
- e. Inspection of the open-top floating roof, pontoons, seals, and fire protection system.
- f. Opening, closing, and mechanical repairs and maintenance of open-top floating roof water drains.
- g. Adjustment and repair of the anti-rotation devices.
- h. Painting, cleaning, and cold work (non-spark-producing) surface preparation prior to painting, using hand-held or air-powered tools only.

Note: The internal or covered open-top floating roof should be in a high position.

- i. When required, cutting and drilling operations shall be continuously flushed using water or approved coolant. Only self-tapping screws and bolts shall be used to attach materials to the floating roof.
- j. Installation, replacement, or repair of secondary-seals with the covered open-top floating roof in a high position, provided primary seals are in good condition. Respiratory protective equipment and mechanical ventilation shall be provided, if needed, to maintain atmospheric combustible vapors and toxic exposure levels in the work area within entry permit limits.

- k. Repair or replacement of bonding straps and shunts on open-top floating roofs under carefully controlled conditions to preclude ignition sources.

Note: A means of positive bonding between the open-top floating roof and the tank shell must be maintained at all times.

- l. Removal of blasting grit, dirt, dust, liquid, ice, or snow from the open-top floating roof using hand-held tools or air-powered equipment without creating sparks or heat.
- m. Inspection, measurement of seal gap, installation, repair, or replacement of secondary seals, with the open-top floating roof in a high position.

**8.5.3** Hot work shall not be performed on floating internal or covered open-top roofs of tanks in service.

**8.5.4** Operating conditions or emergencies may require that product be withdrawn from the tank while tasks of short duration involving entry onto the internal or covered open-top floating roof are in progress. These tasks include, but are not limited to, gauging, sampling, inspecting, or minor maintenance work (see 7.5.2).

- a. Product withdrawal shall require the approval of the tank owner or operator and the entry supervisor and shall be controlled by a cold work permit containing the appropriate safety requirements.
- b. Written procedures shall be prepared covering the preventative measures to be taken by the use of blocking, locking, or sealing and tagging to assure that product is only withdrawn from the tank and not put into the tank.
- c. The rate of product withdrawal should be controlled so that the level of the open-top floating roof does not drop more than 5 inches (0.1 meter) per hour.
- d. Atmospheric monitoring shall be continuously conducted during product withdrawal to assure that flammable vapor and toxic exposures do not exceed the levels established by the entry permit.

**8.5.5** Entrant(s) engaged in cleaning liquid product, sludge, rust and scales from internal and covered open-top floating roofs, including pontoons, seals areas, vents and appurtenances, shall wear appropriate approved personal protective clothing and air-supplied respiratory apparatus with escape packs (see API Standard 2015).



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