NFPA 326

Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair

2005 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA 326

Standard for the

Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair

2005 Edition

This edition of NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, was prepared by the Technical Committee on Tank Leakage and Repair Safeguards and acted on by NFPA at its November Association Technical Meeting held November 13–17, 2004, in Miami Beach, FL. It was issued by the Standards Council on January 14, 2005, with an effective date of February 7, 2005, and supersedes all previous editions.

This edition of NFPA 326 was approved as an American National Standard on February 7, 2005.

Origin and Development of NFPA 326

The text of this standard was originally intended as amendments to NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers Without Entry*, and would have expanded the scope of NFPA 327 to those situations in which tank cleaning or repair required that personnel gain entry to the tank. Recognizing the likely conflict that would result, the committee decided that a separate standard would be desirable. An initial draft of NFPA 326, based on the existing text of NFPA 327, was developed by a task group of the committee in January 1990. The draft was revised several times over the following two years, during which time appropriate changes were also made to the text of NFPA 327.

The text of the first edition of NFPA 326 was adopted in 1993.

In May 1999, NFPA 326 was revised to provide safe requirements for the entry, cleaning, and repair of tanks and containers and to provide assistance to the fire service in determining the professional qualifications necessary to perform atmospheric testing of confined spaces, with the goal of issuing hot work permits. Also, all parts of NFPA 327 related to this standard were incorporated into NFPA 326. Consequently, NFPA 327 was withdrawn as an NFPA standard in May 1999.

This edition of NFPA 326 is the result of a major rewrite to comply with the *Manual of Style for NFPA Technical Committee Documents*. In addition, numerous changes have been made to ensure that NFPA 326 correlates with other consensus and industry standards and the U.S. government rules and regulations. The changes ensure that NFPA 326 reflects current technology and practices.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding against fire, explosion, and health hazards associated with entry, cleaning, and repair of tank systems and methods for detecting, controlling, and investigating releases that could cause these hazards.

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NFPA 326

Standard for the

Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair

2005 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for mandatory extracts are given in Chapter 2 and those for nonmandatory extracts are given in Annex B. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall apply to the safeguarding of tanks or containers, operating at nominal atmospheric pressure, that contain or have contained flammable and combustible liquids or other hazardous substances and related vapors or residues.

1.1.2* This standard shall not apply to tank vehicles or tank cars; tanks, bunkers, or compartments on ships or barges or in a shipyard; gas plant equipment or gas distribution systems for natural or manufactured gas; or compressed and liquefied gas cylinders.

1.1.3* This standard shall not apply to hot tapping.

1.1.4* This standard shall not apply to the entry of a tank or container that contains an inert atmosphere.

1.2 Purpose.

1.2.1 The purpose of this standard shall be to provide minimum procedures for the following:

(1) The safe opening, entry, and cleaning of a tank or container that contains or has contained flammable, combustible, or other hazardous substance vapors, liquids, or solid residues
(2) The safe removal of flammable, combustible, or other hazardous substance vapors, liquids, or solid residues from tanks or containers and the safeguarding of these vessels for entry, cleaning, or repair

1.2.2 The purpose of this standard shall also be to provide minimum procedures that permit repair, hot work, or other operations that have the potential to create a fire, an explosion, or another hazard.

1.3 Application. The requirements provided in this standard for safeguarding a tank or container are described in the logical order in which work is typically conducted.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Units.

1.6.1 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.6.2 If a value for measurement as provided in this standard is followed by an equivalent value in other units, the first stated value is the requirement. A given equivalent value might be an approximation.

1.7 Enforcement Requirements. (Reserved)

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publication. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70, *National Electrical Code®*, 2005 edition.

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2.3 Other Publications.

2.3.1 ACGIH Publication. American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.

ACGIH, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, 2004 edition.

2.3.2 ANSI Publication. American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI Z117.1, *American National Standard Safety Requirements for Confined Spaces*, 2003 edition.

2.3.3 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, 6th edition, 2001.

API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, 1st edition, 2001.

API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*, 2nd edition, 1997.

2.3.4 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

NIOSH *Criteria for a Recommended Standard for Working in Confined Spaces*, 1979.

NIOSH *Pocket Guide to Chemical Hazards*, June, 1997.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Shall. Indicates a mandatory requirement.

3.2.4 Should. Indicates a recommendation or that which is advised but not required.

3.2.5 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Adjacent Spaces. Those spaces in all directions from subject space, including points of contact, internal and external, such as decks, sumps, floating roofs, secondary containment areas, interstitial spaces, under floors, supports, tank tops, and bulkheads.

3.3.2 Attendant. A term used to describe U.S. federally regulated industrial workers who are qualified to be stationed outside one or more confined spaces, who monitor authorized entrants, and who perform all of the following duties: (1) remain outside the confined space during entry operations until relieved by another attendant, (2) summon rescue and other needed resources as soon as the attendant determines that authorized entrants might need assistance to escape from confined space hazards, (3) perform nonentry rescues as specified by the rescue procedure listed on the permit.

3.3.3 Bonding. For purposes of tank entry, cleaning, or repair, the joining of metal parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

3.3.4 Combustible Gas Indicator. An instrument that samples air and indicates whether there are combustible vapors present. [**921,** 2004]

3.3.5 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 37.8°C (100°F). [**30,** 2003]

3.3.6 Confined Space. For purposes of tank entry, cleaning, or repair, any tank that meets all three of the following requirements: (1) is large enough and so configured that a person can enter and perform assigned work, (2) has limited or restricted means for entry or exit, (3) is not designed or meant to be continuously occupied. *(See also 3.3.20, Permit Required Confined Space, and 3.3.18, Nonconfined Space.)*

3.3.7 Container. For purposes of tank entry, cleaning, or repair, a vessel intended to contain an accumulation of hazardous substances that is too small for human entry or has a capacity that can be effectively and safely cleaned without human entry.

3.3.8 Degassing. The process of collecting, oxidizing, or treating vapors and gases expelled from a tank or vessel to prevent or reduce the amount of organic volatile compounds released into the atmosphere during vapor- and gas-freeing operations. [**API 2015,** 3.2.10]

3.3.9 Flammable Liquid. Any liquid that has a closed-cup flash point below 37.8°C (100°F) and a Reid vapor pressure not exceeding 2068 mm Hg (40 psia) at 37.8°C (100°F). [**30,** 2004]

3.3.10 Flammable Vapor. For purposes of tank entry, cleaning, or repair, any substance that exists in the gaseous state at normal atmospheric temperature and pressure and that is capable of being ignited and burned when mixed with the proper proportions of air, oxygen, or other oxidizer.

3.3.11 Hazardous Substance. A substance, including combustible and flammable liquids and flammable gases, that is capable of creating harm to people, the environment, or property due to the dangers that can arise from but are not limited to toxicity, reactivity, ignitibility, or corrosivity.

3.3.12 Hot Tapping. The technique of welding and drilling on in-service tanks or containers that contain flammable, combustible, or other hazardous substances.

3.3.13 Hot Work. Any work that is a source of ignition, including open flames, cutting and welding, sparking of electrical equipment, grinding, buffing, drilling, chipping, sawing, or other operations that create hot metal sparks or surfaces from friction or impact.

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3.3.14 Inert Gas. For purposes of tank entry, cleaning, or repair, a gas that is nonflammable, chemically inactive, noncontaminating for the use intended, and oxygen-deficient to the extent required.

3.3.15 Inerting. A technique by which the atmosphere in a tank or container is rendered nonignitible or nonreactive by the addition of an inert gas.

3.3.16 Liquid. Any material that has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Test Method for Penetration of Bituminous Materials.* [**30,** 2003]

3.3.17* Lower Flammable Limit (LFL). For purposes of tank entry, cleaning, or repair, the concentration of a flammable gas or flammable vapor, expressed as a volume percent in air, below which propagation of a flame does not occur upon contact with an ignition source, when tested in accordance with ASTM E 681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases).*

3.3.18 Nonconfined Space. For purposes of tank entry, cleaning, or repair, a space that previously was a confined space but no longer meets any of the requirements for a confined space or a permit required confined space, such as a tank with a large door sheet cut into the side. *(See also 3.3.6, Confined Space, and 3.3.20, Permit Required Confined Space.)*

3.3.19 Oxygen Indicator. An instrument that is capable of detecting, measuring, and monitoring concentrations of oxygen in the atmosphere.

3.3.20 Permit Required Confined Space. For purposes of tank entry, cleaning, or repair, a tank that meets all three of the requirements for a confined space *(see 3.3.6)* and also has one or more of the following four characteristics: (1) contains or has the potential to contain a hazardous substance, (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 floor that slope downwards, tapering to small cross sections, (4) contains any other recognized serious safety or health hazard. *(See also 3.3.6, Confined Space, and 3.3.18, Nonconfined Space.)*

3.3.21 Purging. For purposes of tank entry, cleaning, or repair, the process of displacing vapors or gases from an enclosure or confined space.

3.3.22* Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to a particular subject matter, work, or project. [**1451,** 2002]

3.3.23 Static Electric Discharge. A release of static electricity in the form of a spark, corona discharge, brush discharge, or propagating brush discharge that might be capable of causing ignition under appropriate circumstances. [**77,** 2000]

3.3.24 Static Electricity. For purposes of tank entry, cleaning, or repair, the electrification of materials through physical contact and separation and the various effects that result from the positive and negative charges so formed.

3.3.25 Tank. For purposes of tank entry, cleaning, or repair, a stationary or portable vessel large enough to allow human entry that is intended to contain an accumulation of hazardous substances.

3.3.26 Toxic Materials, Gases, or Vapors. Any substance whose properties contain the inherent capacity to produce injury to a biological system, which is dependent on exposure, concentration, rate, method, and area of absorption.

3.3.27 Toxicity. The degree to which a substance is harmful to humans.

3.3.28 Unstable Liquid. A liquid that, in the pure state or as commercially produced or transported, will vigorously polymerize, decompose, undergo condensation reaction, or become self-reactive under conditions of shock, pressure, or temperature. [**30,** 2003]

3.3.29 Vapor. The gas phase of a substance, particularly of those that are normally liquids or solids at ordinary temperatures. [**921,** 2004]

3.3.30 Ventilation. For purposes of tank entry, cleaning, or repair, the introduction of air into a tank or container to maintain an atmosphere within acceptable limits and provide the required number of air changes per hour.

3.3.31 Work. Activities performed on tanks and containers in accordance with this standard including, but not limited to, safeguarding, repair, hot work, cleaning, change of service, maintenance, inspection, and transportation.

Chapter 4 Basic Precautions

4.1 General.

4.1.1 Extreme caution shall be used when work is performed on a tank or a container that holds or has held flammable, combustible, or other hazardous substances.

4.1.2 Extreme caution shall be used when work is performed on a tank or container that contains vapors related to the substances that are stored or were previously stored therein.

4.1.3 Before any work is performed on a tank or a container that has held flammable, combustible, or other hazardous substances, the tank or container shall be made safe.

4.1.4 The persons conducting the work shall have a thorough understanding of the following:

(1) The characteristics of the substance that is stored or was previously stored in the tank or container
(2) The potential health and safety risks associated with the work to be conducted
(3) The procedures for safeguarding the tank or container prior to conducting the work

4.1.5 Work on tanks or containers that contain or have contained hazardous substances shall be performed only by trained personnel who understand the associated hazards and who are sufficiently qualified, trained, or educated to safely carry out the necessary operations.

4.1.6 Work on tanks or containers shall be permitted only after the characteristics of the hazardous substance contained or previously contained therein and of the atmosphere within the tank or container have been determined, the specific hazards have been identified, and safe procedures have been established. When establishing safe procedures, the following shall be checked:

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(1) All compartments of a multicompartment tank or container
(2) Annular (interstitial) space of a secondary containment-type tank or container
(3) Vapor seals
(4) Under tank floors
(5) All types of pontoons and pipe supports
(6) Any other areas where vapors or residues can be trapped

4.1.7 All permit(s) required by the authority having jurisdiction shall be obtained prior to beginning work.

4.1.8 Work shall not begin on tanks or containers that contain or have contained unstable liquid or reactive materials until information is obtained regarding safe cleaning procedures.

4.1.9 Nonreactive cleaning materials shall be used where required.

4.1.10 This standard shall not be relied upon to include all the details necessary to perform the activities for safeguarding tanks and containers for entry, cleaning, or repair, and relies on other standards and procedures for some of these details. The referenced publications described in Chapter 2 shall be consulted, as applicable. *(See also Annex B.)*

4.1.11 Prior to opening or accessing tanks or containers, any internal pressure shall be reduced to atmospheric pressure. Tank or container vapors shall be vented to a safe location or, where required, degassed.

4.1.12 A procedure shall be established for notifying the appropriate emergency response services in the event of a fire or other emergency.

4.1.13 A qualified person shall stipulate the requirements necessary to protect personnel working in or around the tank from exposure to hazardous substances.

4.1.14 If hazardous chemicals are used for rinsing or cleaning a tank or container, the qualified person shall stipulate any protective equipment that is required to guard against possible injury.

4.1.15 When a proprietary cleaning solution is used, the manufacturer's instructions for safe handling and use shall be followed.

4.2 Ignition Concerns. This section shall apply to tanks or containers that contain or have contained flammable or combustible liquids or vapors.

4.2.1 Where the potential exists that the tank or container contains flammable vapors, a hot work permit shall be issued to conduct any operations that constitute a source of ignition.

4.2.2 Prior to conducting any procedures required by this standard, the area around the tank or container shall be safeguarded from all sources of ignition.

4.2.2.1 The area to be safeguarded and the methods of control to be used shall be determined by the qualified person based on the potential for ignition around the tank or container.

4.2.2.2 Following completion of 4.2.2.1, the area shall be inspected for flammable liquids and tested for the presence of flammable vapors.

4.2.2.3 Barricades and warning signs reading "NO SMOKING — FLAMMABLE" shall be provided and placed in accordance with the requirements of the authority having jurisdiction.

4.2.3 Equipment that is capable of providing a source of ignition shall not be permitted within the area of the tank or container until the area around the tank or container has been tested and found to be safe.

4.2.4* Before operations are started, the qualified person shall determine safe procedures for working on tanks or containers that have the potential for pyrophoric action or that have contained nitrocellulose, pyroxylin solutions, nitrates, chlorates, perchlorates, peroxides, and other materials that contain enough oxygen to support combustion.

4.2.5 The qualified person shall determine any fire-fighting equipment to be provided in the area, based on the actual and potential hazards. The qualified person shall require that the equipment be in place before issuing a hot work permit and shall ensure that assigned persons are qualified in the use of the fire-fighting equipment.

4.2.6* The qualified person shall stipulate the precautions needed to prevent accumulation and discharge of static electricity.

4.2.7 Any electrical equipment used shall comply with the following:

(1) Be approved for Class I, Group D, Division 1 or for Zone 0 or Zone 1 hazardous (classified) locations, as defined in NFPA 70, *National Electrical Code*
(2) Be listed on the applicable permit
(3) Be inspected by a qualified person to ensure that it is in an operable condition

Chapter 5 Preparation for Safeguarding

5.1 Lockout/Tagout.

5.1.1* All electrical circuits or other energy sources supplying power to pumps or other equipment connected to the tank or container that are a potential hazard to workers in the area of the tank or container shall be disconnected or disengaged and locked out or tagged out, or both, according to applicable regulations.

5.1.2 Where there is a need to test, position, or activate equipment by temporarily removing the lock or tag, or both, a procedure shall be developed and implemented to control potential hazards to the workers and shall be authorized by the qualified person.

5.1.3* Any removal of locks, tags, or other protective measures shall be done in accordance with applicable regulations and the procedure set forth in 5.1.2. *(See also A.5.1.1.)*

5.1.4 Lockout or tagout, or both, of equipment, systems, and processes shall be confirmed by the qualified person prior to performing work on the tank or container.

5.2 Removal of Flammable, Combustible, or Other Hazardous Substances, Liquids, or Gases.

5.2.1 Prior to opening the tank or container, as much hazardous substance, water, and sediment as practical shall be removed from the tank or container using fixed piping and connections. This process shall include the removal of liquids or gases from any internal piping, traps, and standpipes that can be drained or pumped without opening the tank or container.

5.2.2 All piping or conveyances for flammable, combustible, or other hazardous substances connected to the tank or container shall be drained, flushed, or isolated.

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5.2.3 Where reactivity and solubility are not a concern, water or fuel oil or an approved chemical shall be permitted to be pumped into the tank or container through fixed piping or connections to float any remaining liquid from a low spot so that it can be drained or pumped from the tank or container.

5.2.4 Where flammable or combustible liquids or vapors are contained or have been contained in a tank or container, approved explosionproof electric, steam-driven, or air-driven pumps shall be used.

5.2.5* Pump motors, suction hoses, nozzles, and lines, as well as receiving tanks, containers, trucks, or vessels, shall be bonded to the tank or container being emptied to prevent static electricity ignition hazards. *(See also A.4.2.6.)*

5.2.6 All liquids, rinseates, solid residues, and vapors that are generated as a result of these cleaning and safeguarding procedures shall be disposed of in accordance with the applicable regulatory requirements.

5.2.7 Any remaining product in the tank that cannot be removed as described in 5.2.1 through 5.2.6 shall remain in the tank until the tank is safeguarded and then opened for product removal. *(See Chapter 9 for tank entry requirements.)*

5.3 Isolation.

5.3.1 Prior to opening, the tank or container shall be isolated from all supply and dispensing piping systems.

5.3.1.1 If the tank or container on which work is to be performed is equipped with a manifold vent, vapor recovery system, fill line, siphon assembly, or other methods of connection to other tanks or containers, the qualified person shall determine the measures required to isolate that tank or container from all other tanks or containers.

5.3.1.2 All piping connected to the tank that is capable of producing a hazard shall be isolated by being disconnected, plugged, double-blocked and bled, or blanked off.

5.3.1.3 Pipe plugging shall be permitted only after an analysis is made by a qualified person to ensure that the plug is suitable and capable of withstanding any potential pressure in the piping that might dislodge the plug.

5.3.2 The vents for the tank or container on which work is to be performed shall be isolated from the vents of other tanks or containers that might still be in service, and a separate, temporary vent for the tank being entered shall be provided, if necessary.

5.3.3 Valves shall not be relied on to prevent the flow of material unless a locked and tagged double-block and bleed arrangement is provided.

Chapter 6 Testing Procedures

6.1 General Procedures.

6.1.1 To determine that an atmosphere is safe for the designated entry, cleaning, or repair work, tests for oxygen and for flammable, combustible, or other hazardous substance vapors, fumes, or dusts shall be made with an appropriate instrument as follows:

(1) Before entry or re-entry
(2) Before start of alterations or repairs
(3) Before and during any hot work, cutting, welding, or heating operations
(4) Continuously or periodically during the course of the work to be as determined by a qualified person
(5) After cleaning the interior of each tank or container to determine that the cleaning procedures have been effective
(6) After any process or activity has occurred that might change the atmosphere within the tank or container

6.1.2 Precautions shall be taken to ensure that tanks or containers that have held liquids with high flash points do not become hazardous during cutting and welding operations.

6.1.3 The qualified person shall determine whether or not continued testing for flammable vapor and toxicity is required if previous testing indicates that vapor or toxicity associated with former product storage has been eliminated or is not capable of regeneration above permissible exposure levels.

6.1.4 The qualified persons responsible for testing shall be trained or educated in the use of the instruments, be aware of their limitations, and have an understanding of the significance of its readings.

6.1.5* All tests for oxygen and flammable or toxic vapors and gases shall be conducted using a calibrated and adjusted instrument.

6.1.5.1 The instrument shall be calibrated with a calibration gas that is appropriate to the potential hazards.

6.1.5.2 The adjustment of the instrument shall be checked before each day's or shift's use or more often if the tester or qualified person determines there is a need to do so.

6.1.5.3 The calibration of the instrument shall be performed prior to its first use.

6.1.5.4 Recalibration of the instrument shall be done on a regular basis thereafter, as determined by the user's procedures, the manufacturer's recommendations, historical data regarding need to recalibrate, and before its use following an extended period of nonoperation.

6.1.5.5 The instrument shall be maintained in accordance with the manufacturer's recommendations.

6.1.6 The number and location of sampling points shall be determined by the qualified person based on the size and configuration of the tank or container so as to provide a representative determination of the atmosphere in the tank and potential hazards of the area around the tank.

6.2 Testing for Oxygen Content.

6.2.1 A calibrated oxygen indicator shall be used to determine oxygen content.

6.2.2 The following precautions shall apply:

(1) When a tank or container contains an inert gas or other oxygen-displacing or -generating material, a combustible gas indicator shall not be relied on to give a correct reading.
(2) An oxygen indicator shall be used prior to testing for combustible gas to ensure that the correct amount of oxygen is present, in accordance with the instrument's manufacturer, to provide an accurate reading of the gas or vapor being measured.

6.3 Testing for Flammable Vapors.

6.3.1 To determine flammable vapor content, a calibrated and adjusted combustible gas indicator shall be used.

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6.3.2* All work in or around the tank or container shall be stopped immediately when the flammable vapors in the atmosphere exceed 10 percent of the lower flammable limit (LFL). The source of the vapors shall be located and eliminated or controlled.

6.3.3 Equipment that can provide a source of ignition shall not be permitted within the safeguarded area of a tank or container being cleaned, entered, or repaired until the area has been tested *(see Section 4.2)* and found to be vapor free in accordance with 8.2.4 and a hot work permit has been issued by a qualified person.

6.3.4 During ventilation or purging of any tank or container, the flammable vapor concentration of the effluent shall be tested as often as required by the qualified person to determine the flammability and toxicity of the vented vapors.

6.3.5 The qualified person shall determine the direction of the vented effluent to ensure that it does not reach a source of ignition.

6.3.6* If an eductor is used for ventilation, the eductor shall create a vacuum that draws air through at least one tank or container opening and discharges through the opening to which it is attached.

6.3.6.1 Testing for flammable vapors shall be conducted using a combustible gas indicator with its probe inserted into the probe hole provided in the side of the eductor.

6.3.6.2 Testing shall be performed with the eductor on and tightly secured and bonded to the tank or container.

6.3.6.3 When a reading of 10 percent or less of the LFL is obtained, the eductor shall be shut off and readings taken again after a few minutes' waiting time.

6.3.6.4 If the readings in the tank or container are taken through the fill opening, any fill tube that extends into the tank or container shall be removed prior to purging or ventilation operations.

6.3.6.5 The eductor shall be immediately turned on after the last test in the tank or container, and the tank or containers effluent shall be tested thereafter as long as ventilation continues and as often as determined necessary by the qualified person.

6.3.7* If an air blower is used for ventilation, the blower shall force air into the tank or container through at least one tank or container opening and discharge through another opening.

6.3.7.1 Testing for flammable vapor concentrations shall be performed with a combustible gas indicator whose probe is placed in the tank's or container's discharge opening.

6.3.7.2 When a reading of 10 percent or less of the LFL is obtained, the air blower shall be shut off and readings taken again after a few minutes' waiting time.

6.3.7.3 If readings in the tank or container are taken through the fill opening, any fill tube that extends into the tank or container shall be removed prior to purging or ventilation operations.

6.3.7.4 The air blower shall be immediately turned on after the last test in the tank or container, and the tank's or container's effluent shall be tested thereafter as long as ventilation continues and as often as determined necessary by the qualified person.

6.3.8* When a tank or container is tested prior to the start of hot work, any indication of flammable gas or vapor in excess of the established allowable limits shall require additional ventilation, purging, recleaning, or further safeguarding by one of the methods described in this standard, as specified by the qualified person, prior to the issuance of a hot work permit.

6.3.9* When testing a tank or container during hot work, any indication of flammable gas or vapor in excess of the established allowable limits shall require the immediate cancellation of the hot work permit.

6.3.10* Additional ventilation, recleaning or any additional further safeguarding by one of the methods described in this standard, as specified by the qualified person, shall be conducted prior to retesting and reissuance of the hot work permit.

6.4 Testing for Toxic Vapors and Gases.

6.4.1 This section shall not apply to substances that do not have adverse health effects.

6.4.2 Testing for toxic vapors and gases with appropriate instrumentation shall be required to identify the level of exposure.

6.4.2.1* Guidance regarding maximum levels of these substances shall be found in the Material Safety Data Sheet (MSDS) for each substance; applicable regulations and other OSHA substance-specific standards; ACGIH *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*; and the NIOSH *Pocket Guide to Chemical Hazards.*

6.4.3 The qualified person shall obtain assistance in selecting appropriate testing procedures from the applicable regulatory agency or from a safety and health or industrial hygiene professional.

Chapter 7 Control or Removal of Vapors

7.1 General.

7.1.1* Flammable vapors in a tank or container shall be permitted to be vented with air or purged with inert gas, water, or steam *(see Section 10.5)*.

7.1.2 The qualified person shall select the method of ventilating or purging the tank or container on which work will be performed in accordance with regulatory requirements, facility and contractor programs, and procedures and industry standards.

7.1.3 Flammable or combustible liquids or vapors found in spaces adjacent to or within the space containing or having contained hazardous substances shall be removed or controlled prior to proceeding. Such spaces shall include, but not be limited to, interstitial spaces, columns, floats, hollow structures, floating roofs, pontoons, tank floors, multiple-compartment tanks or containers, vapor seals, pipe supports, and any other areas where vapors or residues can be trapped.

7.1.4 Other hazardous substances and vapors that are not flammable or combustible but have adverse environmental or human health effects shall be eliminated or controlled prior to proceeding.

7.1.4.1 The methods identified in Sections 7.2 through 7.5 shall apply to the removal or control of these other hazardous substances whether they be liquids, solids, vapors, dusts, fumes, mists, or gases.

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7.1.4.2 The specific hazardous substances and the methods of their removal or control shall be identified by the qualified person prior to proceeding with ventilation or purging.

7.1.5 Prior to removal of vapors from a tank or container, applicable regulations, codes, and standards shall be reviewed by the qualified person, who shall identify any specific requirements for the handling, degassing, or discharging of vapors or liquids while the activities described in this standard are conducted and indicate appropriate requirements or controls on the permit.

7.1.6 Where a tank is located indoors or in an enclosed or confined area, including but not limited to under a building, under a stairwell, or in an open-sided shed, the qualified person shall stipulate the measures to be taken to prevent the accumulation of flammable or toxic vapors and gases within the building or enclosed or confined area.

7.2 Removal of Flammable Vapors by Displacement with Air (Ventilation).

7.2.1 Where there are openings large enough to accept them, approved air movers (eductors and blowers) that do not provide an ignition source shall be attached so that air is drawn through or pumped into one opening and the atmosphere within the tank or container is discharged through another opening a sufficient distance away from the first opening to provide for cross ventilation in the tank.

7.2.2 If openings cannot accommodate an air mover, the tank or container shall be ventilated to remove flammable vapors by introducing fresh air that will circulate through the tank or container and be degassed or discharged to the outside.

7.2.3 Precautions shall be taken to control or remove all ignition sources from the area since vapors can be present in the flammable range both inside the tank or container and at the point of discharge.

7.2.4 A bond shall be maintained between the air mover and the tank or container being ventilated in order to reduce the chance of static electric ignition.

7.2.5* Precautions shall be taken to control static electricity accumulation through bonding and grounding in order to prevent the possibility of static electric discharge during ventilating operations.

7.2.6 Where ventilating a tank with air, the air pressure in the tank shall not exceed the allowable maximum design pressure for the tank.

7.2.6.1 To prevent excess air pressure, the vent line shall be checked to make certain it is free of blockages, obstructions, or traps.

7.2.6.2 All discharges or venting to the atmosphere during ventilation shall be at a minimum of 3.7 m (12 ft) above the ground surface and away from any areas that might contain sources of ignition.

7.2.7 Displacement of the tank or container atmosphere with air shall be accomplished by one of the following methods:

(1) A negative pressure or vacuum shall be used to pull outside air into the tank or container using an eductor air mover or other equipment.
(2)*A positive pressure or diffused air blower shall be used to push outside air into the tank or container.

7.2.7.1 When the method described in 7.2.7(1) is used, the following shall apply:

(1) The connection between the eductor and the tank or container shall be airtight.
(2) Air shall be drawn through the tank or container to allow cross ventilation and removal of vapors.
(3) All equipment shall be bonded to prevent static electric discharges.

7.2.7.2 When the method described in 7.2.7(2) is used, the following shall apply:

(1) If a fill opening that extends into the tank or container is used as an air supply point, the portion of the fill pipe that extends into the tank shall be removed.
(2) The air shall be supplied from a compressor or blower that has been checked for delivery of clean air that is free of flammable or toxic vapors.
(3) The air-diffusing pipe, if used, shall be bonded to the tank or container to prevent static electric discharges.

7.3* Removal of Flammable Vapors by Displacement with Inert Gas.

7.3.1 When a tank or container is to be inerted for purposes other than entry, the qualified person shall be familiar with the limitations and characteristics of the inert gas being used.

7.3.2 Upon completion of inerting, the oxygen content shall be monitored as often as necessary as determined by the qualified person and maintained at either less than 8 percent total oxygen or less than 50 percent of the minimum oxygen concentration required to support combustion, whichever is less.

7.3.3 The condition specified in 7.3.2 shall be maintained during the entire period that work is in progress and until the tank or vessel is returned to service or cleaned and taken out of service. *(See the procedures for inerting in 7.3.4 through 7.3.14.)*

7.3.4 All openings in the tank or container shall be securely closed, except for the access opening and vent.

7.3.5 The inert gas shall be introduced into the tank or container through a pipe or hose that extends to a point that is near the bottom of the tank and as far away as possible from the portion of the tank where repairs or other activities will be conducted in order to allow for uniform reduction of oxygen in the tank or container.

7.3.6 The inert gas shall be introduced into the tank in a manner that allows distribution of the inert gas throughout the tank or container, based on the internal structure of the tank or container.

7.3.7 Any metal components of the equipment used to introduce the inert gas shall be bonded to the tank or container.

7.3.8 All spaces to be inerted shall be sufficiently intact to retain the inerting medium.

7.3.9 When inert gas is introduced under pressure, low pressure shall be used in order to reduce the generation of static electricity.

7.3.10 The oxygen content shall be measured directly by means of an oxygen monitor.

7.3.11* A sign shall be conspicuously posted that warns of the hazard of inert gas and forbids entry into the tank by unauthorized persons during the inerting process.

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7.3.12 Entry into inert confined spaces for inspection, testing and work shall be allowed only as authorized by an entry permit issued by the qualified person who has determined the hazards and provided for the applicable controls and protection.

7.3.13 When work is completed and prior to entry into the tank without restrictions, inerting media shall be removed to achieve oxygen, vapor, and toxic concentrations in accordance with 8.2.1. If the inerting medium is to remain in the tank, the tank shall be secured and a sign shall be posted in accordance with 7.3.11.

7.3.14 Special Requirements for Carbon Dioxide. When carbon dioxide is used for inerting, the following shall apply:

(1) Portable carbon dioxide fire extinguishers shall not be used as the source of the inert gas.
(2) When solid carbon dioxide is used, it shall be crushed and distributed evenly over the greatest possible area for rapid sublimation.
(3)*The oxygen percentage shall be permitted to be calculated from the percentage of carbon dioxide in the tank or container measured by means of a carbon dioxide indicator.

7.4 Removal of Flammable Vapors by Displacement with Water, Fuel Oil, or Chemicals.

7.4.1 If the flammable, combustible, or other hazardous substance that was previously contained is known to be displaced by or soluble in water, fuel oil, or an approved chemical, then the removal of vapors shall be permitted to be accomplished by completely filling the tank or container with water, fuel oil, or the chemical and draining the tank or container, repeating the operation as necessary to eliminate the flammable atmosphere.

7.4.2 Removal of vapors shall also be permitted to be accomplished by completely filling the tank or container with water, fuel oil, or an approved chemical.

7.4.2.1 If this method is used, the tank or container shall be completely filled with water, fuel oil, or an approved chemical in order to remove all vapors.

7.4.2.2 Extreme care shall be taken to eliminate any vapor spaces by providing venting or by positioning the tank or container during the filling operation or both.

7.4.3 All liquids, rinseates, solid residues, and vapors that are generated as a result of these cleaning and safeguarding procedures shall be disposed of in accordance with the applicable regulatory requirements.

7.4.4 Water, fuel oil, or an approved chemical shall not be used for the removal of vapors if it will adversely react with the flammable, combustible, or other hazardous substance previously contained in the tank or container.

7.5* Removal of Flammable Vapors by Displacement with Steam.

7.5.1 The qualified person shall review and approve all procedures to accomplish the task safely.

7.5.2 Displacement shall be accomplished by introducing steam into the tank or container through a pipe inserted through an opening near the bottom of the tank or container.

7.5.3 The pipe or connecting steam line shall be bonded to the tank or container.

7.5.4 A manway, gauging hatch, or other opening that is located at the top of the tank or container and is large enough to prevent excess internal pressure shall remain open during the entire steaming operation to relieve pressure buildup during steaming and vacuum formation during cooling.

7.5.5 In order to remove all flammable vapors, the rate of supply of steam shall exceed the rate of condensation so that the whole tank or container is heated close to the boiling point of water.

7.5.6 The tank or container shall be steamed long enough to vaporize or facilitate the removal of the residues from all portions of the walls (shell and heads).

7.5.7 Because steam displaces oxygen, when the atmosphere in the tank or container is tested with a combustible gas indicator, the tank or container shall be allowed to cool until excess water vapor has condensed, or the sample shall be drawn through a drying tube filled with calcium chloride or other drying agent *(see instrument manufacturer's recommendations)* to keep water vapor from entering the instrument.

7.5.8 The following precautions shall apply:

(1) Displacement of flammable and combustible vapors with steam is extremely hazardous and is not recommended if alternate methods can be used.
(2) Displacement with steam is capable of generating static electric charges.

Chapter 8 Inspection and Certification of Tanks and Containers

8.1 General.

8.1.1 Once the applicable procedures in Chapters 4 through 7 have been completed, a qualified person shall test and inspect the tank or container and certify, in writing (usually by issuing a permit), that certain activities such as entry, hot work, or cold (safe) work are permitted to proceed using the designations in Section 8.2.

8.1.2 The certificates (permits) shall include a description of the work authorized to be performed and the criteria for protecting personnel and maintaining safe conditions during the work.

8.2* Designations. The designations in 8.2.1 through 8.2.7 shall be consistent with applicable regulatory requirements and industry standards.

8.2.1 Enter Without Restrictions.

8.2.1.1 Tanks, containers, or spaces designated as "Enter Without Restrictions" shall meet all of the following conditions:

(1) The oxygen content shall be at least 19.5 percent and not greater than 23.5 percent by volume.
(2) The LFL shall be less than 10 percent.
(3) Any toxic gases or vapors related to the hazardous substances, coatings in the tank, or inerting media shall be within the permissible concentrations.
(4) The residues or materials associated with the work shall not produce gases or vapors above the permissible concentrations while maintained as specified by the permit.

8.2.1.2 If any of the conditions in 8.2.1.1 are not met, then the space shall not be designated "Enter Without Restrictions."

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8.2.2 No Entry Allowed. The designation "No Entry Allowed" shall mean that personnel shall not be authorized to enter the tank, container, or space so designated.

8.2.3* Enter with Restrictions. The designation "Enter with Restrictions" shall mean that, in the tank, container, or space so designated, entry for work shall be contingent on protective equipment, clothing, or time, as applicable, as specified by the permit.

8.2.4 Hot Work Allowed. Tanks, containers, piping, or spaces designated as "Hot Work Allowed" shall meet all of the following conditions:

(1) The oxygen content shall be at or below 23.5 percent by volume.
(2) Before hot work is started, the LFL within the tank or container shall be 0 percent LFL.
   (a) During the course of the hot work, if the LFL rises to 10 percent, all work shall stop, personnel shall leave the tank, and ventilation shall continue until the LFL is again at 0 percent.
   (b) The permit shall then be reissued to continue the hot work.
(3) The residues, scale, or preservative coatings shall be removed sufficiently to prevent the spread of fire and shall not be capable of producing an oxygen concentration greater than 23.5 percent or an atmospheric concentration of flammable vapors above 10 percent of the LFL in the presence of hot work while maintained as directed on the hot work permit.
(4) Flammable or combustible liquids or vapors found in spaces adjacent to or within the space containing or having contained hazardous substances shall be removed or controlled as specified by the hot work permit.

8.2.5 Hot Work Not Allowed. The designation "Hot Work Not Allowed" shall mean that, in the tank, container, piping, or space so designated, hot work shall not be authorized by the permit.

8.2.6 Limited Hot Work Allowed.

8.2.6.1 The designation "Limited Hot Work Allowed" shall mean that, in the tank, container, piping, or space so designated, all of the following shall apply:

(1) Tanks or spaces with residues or preservative coatings whose flash points are 82.2°C (180°F) or greater and that are free of flowing residues or coatings shall be permitted to be partially cleaned for limited hot work.
(2) The qualified person shall verify the flash points and the toxic and hazardous characteristics of the residues or coatings and implement the applicable controls prior to issuing the hot work and entry permits.
(3) The qualified person shall also take into consideration any fumes or vapors that might be emitted from residues and coatings subject to heat during hot work.
(4) To prevent the spread of fire, an area shall be cleaned a sufficient distance in all directions, including below the area of the hot work, so that sparks or slag will not drop or be thrown into uncleaned areas of the space. The area shall be cleaned to meet the requirements of the standard safety designation "Hot Work Allowed."
(5) A fire watch shall not be used in lieu of cleaning to establish a safe condition.
(6) The nature, location, and extent of the hot work shall be listed on the qualified person's permit.
(7) The portion(s) of the tank or container subjected to hot work shall meet the requirements of 8.2.4(3).
(8) The entire tank or container shall meet the requirements of 8.2.4(1), 8.2.4(2), and 8.2.4(4).
(9) The nature or type of hot work shall be limited or restricted and shall be so indicated on the hot work permit.

8.2.6.2 This designation shall include a statement that describes the exact location of the hot work, the nature and type of the hot work, and the limitations or restrictions of the hot work.

8.2.7 Inerted.

8.2.7.1 The designation "Inerted" shall mean that, in the tank, container, piping, or space so designated, all of the criteria in Section 7.3 have been met.

8.2.7.2 This designation shall include a statement that describes the inerting media used and its final disposition.

Chapter 9 Procedures for Access to and Entry of Tanks

9.1 General.

9.1.1 Prior to issuing a permit for access to or entry into a tank, the qualified person shall check to ensure that flammable vapors have been controlled or removed from the tank in accordance with the procedures and requirements of Chapters 7 and 8 of this standard.

9.1.2 Testing for an atmosphere that is suitable for entry shall be conducted in accordance with Chapter 6.

9.1.3 Applicable control measures for any other hazards or potential hazards that have been identified for the material(s) (products) previously stored in the tank and for the materials to be used to purge and clean the tank or container shall be indicated on the permit and monitored by the qualified person.

9.2 Access to Tanks.

9.2.1* If excavation is necessary to gain access to the tank, the access pit or trench shall be large enough to allow entry into and exit from the tank and shall comply with applicable regulations. In such cases, the qualified person and personnel shall be familiar with and shall comply with all applicable regulations covering excavations and trenching.

9.2.2 If a manway is to be used for access to the tank, the bolts and cover shall be removed.

9.2.3 When work is completed at the end of the shift or day or at any time when the tank is left unguarded prior to its being cleaned, vapor and toxic freed, and classified as a non–permit required confined space (or a nonconfined space), the manway shall be replaced using at least half the number of bolts to protect the tank from unauthorized access.

9.2.4* If no manway exists, an opening large enough to allow entry into and exit from the tank and that complies with applicable regulations shall be cut into the tank.

9.2.4.1 The section to be removed shall be marked, and a hole drilled with an air-driven drill at one corner of the section, using a lubricating material to reduce friction, heat, and possible sparks.

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9.2.4.2 After the hole is drilled, the tank atmosphere shall be tested to verify a safe atmosphere by inserting the atmosphere testing instrument probe an appropriate distance into the drilled hole.

9.2.5 Cutting shall not be permitted on tanks containing a flammable or combustible atmosphere unless all of the following conditions are met:

(1) The tank shall first be purged or vented until the internal atmosphere is at or below 10 percent of the LFL.
(2) If purging or venting does not achieve an atmosphere that is at or below 10 percent of the LFL, the tank shall be inerted to eliminate or reduce the amount of oxygen in the atmosphere.
(3) A permit shall then be issued to cut the tank access opening using an air-driven saber saw or snipper and using a nonflammable lubricating material to reduce friction and heat and to prevent possible sparks.
(4) Prior to making the final cut, the plate shall be supported to prevent its falling into the tank.

9.2.6 The following caution shall be noted: Drilling and cutting operations have the potential to create heat and sparks on the inner surface of the tank which could result in ignition if air and flammable vapors are present inside the tank in the explosive range or if flammable residues are present inside the tank. The tank shall be either inerted or made vapor free prior to and maintained vapor free during cutting operations by ventilation.

9.3 Tank Entry.

9.3.1* Before entering tanks, the qualified person issuing the entry permits and personnel assigned as entrants, attendants, and rescuers shall be familiar with the applicable procedures described in API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*; API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*; API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*; ANSI Z117.1, *American National Standard Safety Requirements for Confined Spaces*; and NIOSH *Criteria for a Recommended Standard for Working in Confined Spaces*.

9.3.2 The vent lines or manway shall remain clear and unobstructed to allow continuous ventilation and provide for the appropriate number of air changes during entry and work periods in accordance with the requirements of 7.2.1.

9.3.3 Other lines and openings shall be isolated in accordance with the facility or contractor isolation procedures to keep liquids or vapors from entering the tank.

9.3.4 If natural ventilation is not capable of controlling the vapor-in air levels of the tank's atmosphere within the permit limits or to maintain the required air changes and air quality, continuous mechanical ventilation shall be used while the confined space is occupied.

9.3.5 The qualified person shall determine and stipulate on the permit any additional precautions or controls that shall be taken if the tank bottom is perforated such that liquids or vapors that might be present in the soil under the tank or in the tank double bottom might re-enter the tank through the perforation.

9.3.6 The qualified person shall determine and implement controls required to prevent liquids or vapors from entering into the tank from sumps, roof support columns, pontoons, internal piping, appurtenances, or other means.

9.4 Closing the Tank Access Opening.

9.4.1 If an access opening has been cut into a tank that has been designated a confined or permit required confined space, the opening shall be closed or protected, either temporarily or permanently, depending on the disposition of the tank such as at the end of the work period or whenever the tank is left unattended.

9.4.2 Upon reopening the tank, atmospheric testing shall be conducted and the qualified person shall issue or reissue permits for work and entry.

Chapter 10 Cleaning Tanks and Containers

10.1 General.

10.1.1 The procedures outlined in Chapters 4 through 7 shall be followed to the extent applicable to the tank or container to be cleaned.

10.1.2 If indoor cleaning is necessary, ventilation shall be sufficient to prevent the accumulation of flammable vapors inside a building.

10.2 Purpose and Extent of Cleaning. Where cleaning is necessary in preparation for hot work, change in service, or other purposes, the procedures in this section shall apply.

10.2.1* Cleaning in Preparation for Hot Work. Tanks or containers shall be cleaned prior to hot work, and hot work shall be conducted in accordance with the requirements of this standard and other applicable standards and regulations.

10.2.2 Cleaning for Change in Service.

10.2.2.1 Tanks or containers shall be cleaned prior to a change in service if residues could contaminate or be incompatible with new material in the tank or container.

10.2.2.2 Selection of a cleaning procedure shall be based on the chemical nature and characteristics of the residue and the characteristics of the new material to be stored in the tank.

10.2.3* Cleaning for Other Purposes. Selection of a cleaning procedure shall be based on the activity to be conducted, the intended use of the tank or container, and the chemical and physical properties of the material stored.

10.3 Removal of Residual Liquids and Solids.

10.3.1 Accumulation. Liquid or solid residue accumulation, including all visible moisture, on the bottom of the tank shall be removed and placed in approved containers.

10.3.2 Additional Precautions. Where it is not possible to remove all liquid or solid residues that might allow vapors to recur during work because residues are trapped behind heavy scale or rust and are not easily detected or removed, the qualified person shall evaluate the potential hazard and determine the necessary control measures and ensure that required precautions shall be taken.

10.4 Cleaning Inspection.

10.4.1 After it is cleaned, the tank or container shall be inspected internally to determine the effectiveness of such cleaning.

10.4.2 Containers or tanks that are not entered shall be visually inspected.

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10.4.3 Testing according to Chapter 6 shall be performed prior to inspection to ensure that no harmful vapors are present.

10.4.4 If upon inspection it is determined that the tank or container is not clean, the cleaning procedure shall be repeated.

10.5* Cleaning Methods.

10.5.1 The following methods of cleaning shall be permitted to be used:

(1) Abrasive blasting
(2) Low-pressure water (e.g., triple rinse)
(3) High-pressure water blasting [e.g., 172,250 to 275,600 kPa (25,000 to 40,000 psi)]
(4) High-pressure steam
(5) Special cleaning agents (e.g., solvents, degreasers, neutralizing agents, or emulsifiers)
(6) Physical removal (e.g., vacuuming, shoveling, scraping, wiping, or absorption)

10.5.2 The following caution shall be noted: Steam cleaning, use of special cleaning agents, or high-pressure water blasting might result in the generation of static electric charges.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 The procedures in this standard can apply to pressurized tanks or containers that have been taken out of service and have had their operating pressure reduced to atmospheric pressure and vented.

A.1.1.2 Procedures for making some of the tanks and containers listed in 1.1.2 safe are covered separately in the following publications:

(1) AGA, *Purging Principles and Practices*
(2) ANSI Z117.1, *American National Standard Safety Requirements for Confined Spaces*
(3) API 1631, *Interior Lining and Periodic Inspection of Underground Storage Tanks*
(4) API 2009, *Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries*
(5) API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*
(6) API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*
(7) API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*
(8) API 2207, *Preparing Tank Bottoms for Hot Work*
(9) API 2027 *Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*
(10) NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*
(11) NFPA 306, *Standard for the Control of Gas Hazards on Vessels*
(12) OSHA 29 CFR 1910.146, "Permit-Required Confined Spaces"
(13) OSHA 29 CFR 1910.147, "Control of Hazardous Energy (Lockout/Tagout)"

A.1.1.3 Procedures for hot tapping are covered separately in API 2201, *Procedures for Welding or Hot Tapping on Equipment in Service.*

A.1.1.4 For information on working in an inert atmosphere, see API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry.*

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.17 Lower Flammable Limit (LFL). Also known as the lower explosive limit (LEL). Mixtures below this limit are said to be "too lean."

A.3.3.22 Qualified Person. Designation or selection of qualified persons should be done to ensure that the designations are properly applied to the inspected tank or container. Selection of qualified persons should include careful consideration of those aspects of the qualified person's education, experience, and specialized training necessary to recognize unsafe conditions, specify necessary control measures, and ensure the protection of personnel working in or near the tanks and containers within the scope of this standard.

Individuals possessing the skills and experience necessary to act as qualified persons could be employees of the tank owners, contractors, or third parties.

When selecting or reviewing the credentials of qualified persons, there are several factors that should be considered, including the following:

(1) Experience with the design, function, and operation of the tank or container types
(2) Experience with the physical, chemical, and hazardous properties of the materials previously stored
(3) Experience with the industrial activities to be performed within or on the tank or container
(4) Experience with the instrumentation and inspection techniques used in determining the testing criteria associated with the designations
(5) Knowledge of applicable industry, federal, state, and local safety standards and guidelines referenced in this standard

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The following are several sources of third-party experts who can successfully serve as qualified persons, listed in alphabetical order by designation:

(1) American Petroleum Institute Certified Aboveground Storage Tank Inspectors (recognized for expertise in aboveground storage tank design, structure, function, and operation as it relates to API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*) and Certified Tank Entry Supervisor (recognized for expertise in tank entry and cleaning as it relates to API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*. Contact the American Petroleum Institute, Aboveground Tank Inspector Certification Program, 1220 L Street, NW, Washington, DC 20005.
(2) STI SP001, *Standard for Inspection of In-Service Shop Fabricated Aboveground Tanks for Storage of Combustible and Flammable Liquids*. Contact the Steel Tank Institute, 570 Oakwood Road, Lake Zurich, IL 60047.
(3) American Board of Industrial Hygiene Certified Industrial Hygienists (especially trained in assisting with recognition, evaluation, and control of exposure to potentially toxic materials previously stored in the vessel or used during work in the tank and in eliminating or controlling other common workplace stresses). Contact the American Board of Industrial Hygiene, 6015 West St. Joseph, Suite 102, Lansing, MI 48917.
(4) National Fire Protection Association Certificated Marine Chemists (especially trained in dealing with fire and explosion prevention and hot work safety involving storage vessels and in assisting with recognition, evaluation, and control of exposure to potentially toxic materials previously stored in the vessel or used during work in the tank). Contact NFPA, 1 Batterymarch Park, Quincy, MA 02169.
(5) Board Certified Safety Professionals (especially trained and experienced to create or develop procedures, processes, standards, specifications, and systems to achieve optimal control or reduction of the hazards and exposures that can harm people, property, and/or the environment). Contact the Board of Certified Safety Professionals, 208 Burwash Avenue, Savoy, IL 61874.

Others who can meet the experience requirements listed above can successfully serve as qualified persons, including state and other government certified professionals, nongovernment certified professionals, and persons approved by an authority having jurisdiction.

A.4.2.4 The qualified person should be aware of and determine necessary controls for the hazards associated with materials that contain enough oxygen to support combustion in inert atmospheres.

A.4.2.6 For information on the accumulation and discharge of static electricity, see the following:

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

NFPA 77, *Recommended Practice on Static Electricity*

API 2219, *Safe Operation of Vacuum Trucks in Petroleum Service*

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

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

A.5.1.1 An example of an applicable regulation is 29 CFR 1910.147, "Control of Hazardous Energy (Lockout/Tagout)."

A.5.1.3 An example of an applicable regulation is 29 CFR 1910.147, "Control of Hazardous Energy (Lockout/Tagout)."

A.5.2.5 For information on static electricity ignition hazards, see the following:

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

NFPA 77, *Recommended Practice on Static Electricity*

API 2219, *Safe Operation of Vacuum Trucks in Petroleum Service*

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

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

A.6.1.5 Fresh air can be used for 20.8 percent oxygen, 0 percent LFL, and 0 for most toxic substances.

A.6.3.2 Testing the interior of a tank or container for the presence of ignitible concentrations of flammable gas or vapor is the most important phase of the cleaning procedure and determines whether additional cleaning is needed. Most combustible gas indicators measure the concentration of vapor present as a percentage of the LFL. When a tank or container is oxygen deficient, the reading might be in error. It is essential that those using the indicator be well trained in its use and calibration and that the instrument is in operating condition. Calibration should be done in accordance with the manufacturer's instructions.

In addition, when the tank of container is oxygen rich (the oxygen level is above that of the ambient air outside the tank), the reading will be in error. The qualified person should determine and control the source of additional oxygen before proceeding with testing.

A.6.3.6 If an air mover is used to exhaust a tank or container, discharge from the air mover will be diluted with air used in the device. The results of any tests made at this point will indicate only the change in the vapor concentration inside the tank or container and will not be an accurate measurement of the actual concentration. When the desired low concentration is reached, the inside of the tank or container itself should be checked to determine the actual atmosphere.

A.6.3.7 See A.6.3.6.

A.6.3.8 API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks,* and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks,* contain specific hot work requirements and safe practices and requirements that should be reviewed by the qualified person when permitting hot work inside confined spaces.

A.6.3.9 See A.6.3.8.

A.6.3.10 See A.6.3.8.

A.6.4.2.1 Many hazardous substances stored in tanks and containers or used in cleaning or repairing them can have adverse effects on human health. An example of an applicable regulation is OSHA 29 CFR 1910.1000, Subpart Z, "Air Contaminants."

A.7.1.1 Refer also to API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks,* API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks,* and API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry,* for safe practices and requirements for using inert gas to rid a tank or container of vapor.

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A.7.2.5 For more information, see API 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*; NFPA 77, *Recommended Practice on Static Electricity*; NFPA 69, *Standard on Explosion Prevention Systems*; API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, for bonding practices and requirements.

A.7.2.7(2) For information on underground storage tanks, see API 1604, *Closure and Periodic Inspection of Underground Petroleum Storage Tanks*.

A.7.3 Inerting is a means of safeguarding a tank or container by reducing the oxygen content to the point at which combustion cannot take place. Examples of inert gases commonly used are carbon dioxide, nitrogen, argon, helium, flue gases that meet the oxygen criteria, and mixtures of these gases. These gases can be obtained in cylinders and in tank trucks. Carbon dioxide can also be obtained in solid form. For information on working in inerted spaces, see also API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*.

A.7.3.11 Special precautions are necessary to work in a tank containing an inert atmosphere. These activities are beyond the scope of this standard, and the qualified person should consult the following references prior to allowing entry into a tank or container that contains an inert atmosphere. Refer to API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*, API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, for safe practices and requirements when using an inert gas to rid a tank or container of vapor.

A.7.3.14(3) The oxygen concentration can be determined using the following calculation:

$$\%O_2 = \frac{100 - \%CO_2}{100} \times 20.8$$

A.7.5 See also API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*; API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*; and NFPA 77, *Recommended Practice on Static Electricity*.

A.8.2 For information on entry designations, refer to 29 CFR 1910.146, "Permit-Required Confined Spaces"; API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*; and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*.

A.8.2.3 Entry should be classified as "Enter with Restrictions" if the following conditions exist:

(1) The oxygen content is between 19.5 and 23.5 percent by volume.
(2) Flammable vapors are between 0 and 10 percent LFL.
(3) Atmospheric concentrations of toxic substances are above the permissible exposure level (PEL) or threshold limit value (TLV) and below the immediately dangerous to life or health (IDLH) level and do not expose employees to the risk of death, incapacity, impairment of the ability to self-rescue, or acute illnesses due to health effects.

In atmospheric situations other than those in A.8.2.3(1) through A.8.2.3(3), refer to API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks,* and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, for information on entering tanks with special precautions.

A.9.2.1 See OSHA 29 CFR 1926, Subpart P, "Excavations," for trenching and excavation requirements in the United States.

A.9.2.4 The location of the opening in the tank can be limited by the internal structure of the tank.

A.9.3.1 See also OSHA 29 CFR 1910.146, "Permit-Required Confined Spaces."

A.10.2.1 See also API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*; API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*; API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*; API 2207, *Preparing Tank Bottoms for Hot Work*; API 2027, *Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*; API 2009, *Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries*; and NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*; and OSHA 29 CFR 1910.147, "Control of Hazardous Energy (Lockout/Tagout)."

A.10.2.3 Other activities where tank or container cleaning is necessary include transportation, storage, maintenance, repairs, and internal inspection.

A.10.5 See API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks,* and API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, for safeguards. For information on abrasive blasting, see API 2027, *Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*.

Annex B Informational References

B.1 Referenced Publications. The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2003 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2000 edition.

NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, 2003 edition.

B.1.2 Other Publications.

B.1.2.1 AGA Publication. American Gas Association, 400 North Capitol Street, NW, Washington, DC 20001.

AGA, *Purging Principles and Practices*, 2001 edition.

B.1.2.2 ANSI Publication. American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI Z117.1, *American National Standard Safety Requirements for Confined Spaces*, 2003 edition.

B.1.2.3 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, 3rd edition, 2001.

API 1604, *Closure and Periodic Inspection of Underground Petroleum Storage Tanks*, 3rd edition, 1996.

API 1631, *Interior Lining and Periodic Inspection of Underground Storage Tanks*, 5th edition, 2001.

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API 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*, 6th edition, 1998.

API 2009, *Safe Welding, Cutting and Hot Work Practices in the Petroleum and Petrochemical Industries*, 7th edition, 2002.

API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, 6th edition, 2001.

API 2016, *Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks*, 1st edition, 2001.

API 2027, *Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service,* 3rd edition, 2002.

API 2201, *Procedures for Welding or Hot Tapping on Equipment in Service*, 5th edition, 2003.

API 2207, *Preparing Tank Bottoms for Hot Work*, 5th edition, 1998.

API 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*, 2nd edition, 1997.

API 2219, *Safe Operation of Vacuum Trucks in Petroleum Service,* 1999.

B.1.2.4 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 5, *Standard Test Method for Penetration of Bituminous Materials*, 1997 edition.

ASTM E 681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)*, 2001.

B.1.2.5 STI Publication. Steel Tank Institute, 570 Oakwood Road, Lake Zurich, IL 60047.

STI SP001, *Standard for Inspection of In-Service Shop Fabricated Aboveground Tanks for Storage of Combustible and Flammable Liquids,* 2003.

B.1.2.6 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1910.146, "Permit-Required Confined Spaces."

Title 29, Code of Federal Regulations, Part 1910.147, "Control of Hazardous Energy (Lockout/Tagout)."

Title 29, Code of Federal Regulations, 1910.1000, Subpart Z, "Air Contaminants."

Title 29, Code of Federal Regulations, 1926, Subpart P, "Excavations."

B.1.2.7 Other Publications. *Merriam-Webster's Collegiate Dictionary*, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

B.2 Informational References. (Reserved)

B.3 References for Extracts. The following documents are listed here to provide reference information, including title and edition, for extracts given throughout the nonmandatory sections of this standard as indicated by a reference in brackets [ ] following a section or paragraph. These documents are not a part of the requirements of this document unless also listed in Chapter 2 for other reasons.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2000 edition.

NFPA 921, *Guide for Fire and Explosion Investigations*, 2004 edition.

NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*, 2002 edition.

API 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*, 6th edition, 2001.

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▼

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▼

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▼

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▼

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